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SYLLABUS GUIDE
TO PUBLIC HEALTH EXHIBITS
IN THE
AMERICAN MUSEUM OF NATURAL HISTORY

DEALING WITH WATER SUPPLY, DISPOSAL OF MUNICIPAL WASTES AND INSECT-BORNE DISEASES

An Outline for Teachers and Students

By LAURENCE V. COLEMAN

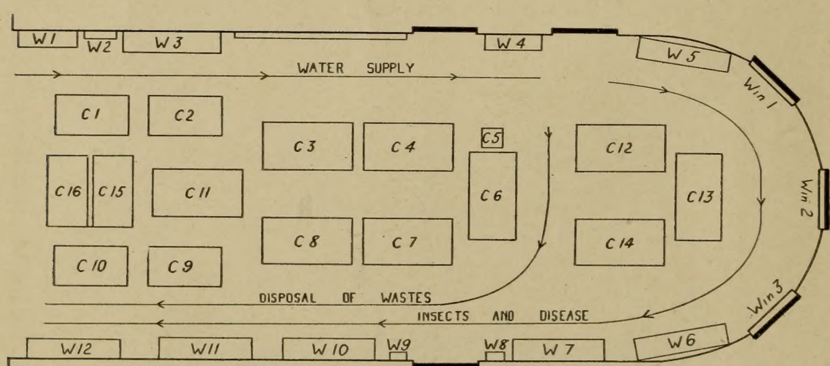
GUIDE LEAFLET SERIES No. 45
MAY, 1917

INTRODUCTION

Man is an animal and the story of his activities properly forms a chapter of natural history.

The exhibits of the Hall of Public Health are planned to illustrate certain important phases of man's relation to his environment—to show how it affects him and how he modifies it with a view to making life safer and more healthful.

It is hoped that this *Guide Leaflet* may be of service to those who wish to learn briefly and connectedly the story which the exhibits have to tell.



PLAN OF HALL OF PUBLIC HEALTH

Showing the arrangement of the exhibits and location of the cases referred to in the Notes.

AMERICAN MUSEUM OF NATURAL HISTORY

SYLLABUS GUIDE
TO THE PUBLIC HEALTH EXHIBITS

WATER SUPPLY

(NOTES REFERRING TO EXHIBITS)

Most of the water on the earth's surface is stored in the oceans, from which it is drawn up or evaporated by the sun to form the clouds.

See 1st panel of frieze, left wall.

The rain is the primary source of all water supplies. Rainfall varies considerably at different places.

WALL CASE 1 shows the number of rainy days at certain places and the actual rainfall in inches at others.
WALL CASE 2 presents graphically rainfall data for the whole United States.

Surface water flows off in rivers—which are swift at first, but slow and winding farther down.

See 3d panel of frieze.
See 4th panel of frieze.

Slowly flowing rivers, unless contaminated by sewage from towns on their banks, are less apt to be dangerous than rapid ones, but safer than either are lakes in which the water is stored—undergoing through storage a natural purification.

See 2d panel of frieze.

Jars of rice in WALL CASE 3 indicate how typhoid bacilli die off during storage but CHART 1 shows a case where purification by storage failed.

A common way of obtaining water supplies for large cities is by impounding streams in artificial lakes and reservoirs.

CENTER CASE 1 shows how a reservoir was formed near Boston, Massachusetts, for this purpose.

Another portion of the rain sinks at once into the ground, often to emerge at a lower level, forming a spring or well,— another common source of public water supply.

In WALL CASE 4 is a section of an artesian well.

Water may be hard or soft, turbid or clear, depending upon the amount and nature of the matter which it contains in solution or in suspension.

The physical character of five samples of water is indicated by blocks in WALL CASE 3.

Drinking water frequently contains microscopic organisms, most of which are harmless, although some of them produce tastes and odors in the water.

In WALL CASE 3 are displayed enlarged glass models of micro-organisms (algae, diatoms and protozoa) which occur in water.
Their seasonal prevalance is shown by CHARTS 2 and 3.

Occasionally disease-producing bacteria are present, derived either from direct sewage discharge or from the washing in of human wastes from the shore or through the ground.

In CENTER CASE 2 and in CHART 5 are given instances of epidemics caused by disease-producing bacteria in drinking water.

Impure water must be either stored or treated before it is safe for drinking. Treatment may be by slow sand filtration, by rapid mechanical filtration after the addition of chemicals which produce a flocculent filtering layer, or by disinfection.

In CENTER CASE 3 is a model of a mechanical filter and in CENTER CASE 4 that of a slow sand filter and of an apparatus for disinfection with liquid chlorine.

A model of a plant for treating water with bleaching powder is exhibited in CENTER CASE 5.

Purification of a water supply is usually followed by a marked drop in the typhoid fever death rate; from a purely economic standpoint this saving of life far outweighs the cost of treatment.

The data for a number of cities are presented in CHARTS 4 and 6.

SEWAGE DISPOSAL

Cities usually discharge their sewage into the nearest large body of water: New York, for example, uses its two rivers and the bay for this purpose.

The sewage, sometimes washed back and forth for days by the tides, causes our waterways to be grossly polluted. Such a condition, always a menace to health, is especially dangerous in fresh-water streams or lakes where the polluted water has access to the supply of some other city.

CHARTS in CENTER CASE 6 show the system of sewers in use by New York at present and the system as it will be when completed, the path of a float set adrift in the Hudson River, and the extent of pollution at various points. In the same case is depicted a scene on the water-front showing one dangerous phase of pollution.

The food supply may also become contaminated in this way.

Another model in CENTER CASE 6 shows one way in which shellfish become polluted.

Such local nuisances and dangers to health may be avoided by treating sewage before it is finally discharged. To do this a city has several alternatives but the most effective process involves a number of successive treatments.

The coarse matter may first be removed by screening, after which the finer material may be allowed to settle as the sewage flows slowly through a sedimentation tank.

CENTER CASE 7 contains models of a coarse bar screen, a revolving mechanical screen and a rotating Riensch-Wurl screen.
A sedimentation tank is also represented in CENTER CASE 7.

Or sedimentation may be combined with digestion of the solids removed by the use of either a septic or an Imhoff tank.

Models of each of these will be found in CENTER CASE 8.

The principle of both is the same, viz., that sludge, if allowed to accumulate under water, will be reduced in amount by the bacteria present in it. Imhoff tanks provide a separate lower chamber for this process.

The treatment may stop here or a final stage may be added, in which the organic matter in the sewage is oxidized and changed to a harmless mineral form.

This oxidization, which is brought about by bacteria, may be effected in either an intermittent sand filter, a contact bed of broken stone alternately filled with sewage and emptied, or a trickling filter—a bed of broken stone through which the sewage percolates after being sprayed over the surface.

CENTER CASE 9 contains an intermittent sand filter in miniature.

Models of two contact beds are shown in CENTER CASE 10.

In CENTER CASE 11 a trickling filter is shown in action.

In the so-called activated sludge process the oxidizing bacteria are cultivated in the sewage sludge itself and are supplied with compressed air from the bottom of the tank.

An activated sludge tank will be found in CENTER CASE 8.

The country dweller may purify his sewage by installing a small septic tank and allowing its effluent to percolate through the sandy soil.

One possible arrangement is shown by a model in CENTER CASE 8.

BACTERIA

Bacteria are minute single-celled plants. Most of them are harmless; some are necessary to the life and industrial pursuits of man; a few cause disease. When properly stained and viewed through a microscope, they are seen to occur in three shapes:

Transparencies in WINDOW CASE 1 are photographs of bacteria as they appear under a microscope.

WINDOW CASE 2 contains enlarged glass models of each type: for example:

balls . . . . Staphylococci (2d panel).
rods . . . . Bacillus of tuberculosis (1st panel).
spirals . . . . Spirochæte of relapsing fever (bottom panel).

Different bacteria vary greatly in proportions and appearance. Some species have long, thread-like processes (flagella), which enable them to swim about, while others are surrounded with slime. A great many contain resistant spores and others contain granules, which give them a barred or spotted appearance.

See bacilli in two central panels.

See acetic acid bacilli just above.

See one of the center panels.
Bacillus of diphtheria (top row).

Bacteria may be made to live and multiply by planting them on a specially prepared jelly. Soon their numbers so increase that a colony of millions of microbes becomes visible at each point where a single germ was planted originally.

Preserved colonies are shown at both sides of WINDOW CASE 1.

INSECT-BORNE DISEASES

An insect may carry disease from one man, or from one animal, to another in two ways:

1. By acquiring and dispersing the parasites during the act of biting.

   A few of the most important diseases carried in this way are:

   Bubonic Plague — carried by the flea.
   Malaria — carried by *Anopheles* mosquitoes.
   Yellow Fever — carried by the *Aëdes* mosquito.
   Typhus Fever — carried by the body louse.
   Sleeping Sickness — carried by the Tsetse fly.
   Tick Fevers — carried by ticks.

   With the exception of Bubonic Plague, these diseases can be contracted only through the agency of insects and in the way described above.

2. By spreading germs lodged on its body and feet.

   Typhoid fever organisms and germ of infant diarrhœa are sometimes carried in this way by the fly.

BUBONIC PLAGUE

(Notes Relating to Exhibits)

Since the sixth century, Bubonic Plague has swept three times over the world, killing millions of people.

CHART 7 gives the range of each pandemic.

CHARTS 9 to 12 are copies of old paintings, showing how the scourge impressed the ancients.

It is a bacterial disease,

An enlarged glass model of the germ (*Bacillus pestis*) will be found in WALL CASE 5,

primarily of the rat,

and on the same shelf are displayed four species of rats most often concerned. CENTER CASE 12 contains a model of part of an actual house, which was badly infested with rats.

spread and carried to man by the bites of infected fleas.

A flea is mounted under a lens in WINDOW CASE 3 and an accurate model of the insect, magnified one hundred and twenty times, is installed in a case at the entrance to the Hall.

In California two species of squirrels are subject to the disease,

Mounted specimens are in WALL CASE 5, and in CENTER CASE 13 the most important species is shown in its natural surroundings.

while in Asia the marmot must be reckoned with. To control the plague we must fight the rat and the other rodents mentioned.

CHART 8 summarizes the methods of control and CHART 13 shows some phases of an anti-plague campaign in New Orleans.

The most effective measures are:

1. Prevention of rat breeding — Clean up rubbish and cut off the rats' food supply.
2. Destruction of rats — Poison or trap them and fumigate enclosed spaces.

In WALL CASE 5 are three good traps and beside them is a model showing the results from their use.

3. Exclusion of rats from dwellings by rat-proofing.

On the 1st shelf is a model of a farm protected against rats

4. Quarantine against vessels from infected regions by placing rat guards on the hawsers, etc.

and one of a schooner with rat guards in position.

Plague, under certain conditions, may also be spread by the mouth spray from a coughing patient.

On the top shelf of WALL CASE 5 are shown the costume and respirator worn to protect against this danger.

A fair degree of immunity may be produced for a short time by the use of vaccine.

Samples of the commercial product are just beneath.

MALARIA

Malaria is an important disease responsible for an annual loss of $100,000,000 in the United States.

An enlarged glass model of *Plasmodium* will be found in WALL CASE 9, and CHART 18 shows its life cycle.

It is caused by a protozoan parasite (*Plasmodium*), living part of its life in the blood of human beings, and part in the body of the *Anopheles* mosquito.

A chart in the top of WALL CASE 6 gives the points of difference between the malaria carrier and the common mosquito. The geographic distribution of the disease and that of its carrier are mapped in CHART 24.

Mosquitoes of this kind become infected by biting a malaria sufferer and spread the disease by subsequently biting healthy persons.

A chart in the upper right corner of WALL CASE 6 shows the intimate relationship between the mosquito season and the prevalence of mosquito-borne disease.

To wipe out malaria we must cure cases by quinine treatment and exterminate the insect-carrier.

A model on the middle shelf illustrates the use of quinine in Panama, and a chart just above it indicates the reduction of malaria in Italy due to the use of quinine dispensed by the Government.

To fight an enemy successfully, its habits must be known. Those of the mosquito are well understood.

A series of three jars giving the life cycle of the mosquito (left) and a set of collecting implements used in studying its natural history are also shown in WALL CASE 6.

Water is essential to mosquito breeding, for on its surface the eggs are laid and in it the early stages must live.

CENTER CASE 14 (to be installed) will contain the reproduction of an actual pool in which malaria mosquitoes were found breeding, while a chart in WALL CASE 6 pictures a breeding place on the shore of the Nile.

Relief maps in CENTER CASES 15 and 16 (near the entrance to the hall) indicate the prevalence of malaria near marshlands.

In warm weather mosquitoes reproduce most rapidly.

A chart in the upper left corner of WALL CASE 6 gives data to illustrate this fact.

Our safety from malaria depends on the following mosquito-control measures:

CHART 23 summarizes the methods of control.

1. Prevention of mosquito breeding —

   Swamps should be drained by ditching.

A special spade for digging ditches is shown in WALL CASE 6, while in CENTER CASE 15 is a relief map of a well-drained marsh. CHART 19 shows a swamp before and after drainage. That drainage pays is proven by a model in CENTER CASE 16 and by the facts presented in CHART 20. In WALL CASE 7 is a model of a concrete ditch as constructed in Panama.

   Overhanging grass should be cut from the edges of all ditches, streams and pools.

In the bottom of WALL CASE 7 is a group showing how this is done in Panama.

Cast-out pots and cans should be removed to prevent the accumulation of rain-water, while for rain-barrels, screening is essential.

A typical vacant lot breeding-place is reproduced in the bottom of WALL CASE 6 and above is a properly screened rain-barrel.

2. Destruction of wigglers —

They may be suffocated by oiling the surface of the water in which they live, or killed by poisoning.

Samples of oil are arranged on the middle shelf of WALL CASE 6, and a jar just above shows the condition produced by oiling. At the lower left corner of the case is a barrel used for applying oil to running water. The picture behind it is of an oiling squad in New Jersey.

A sample of the poison used in Panama is shown.

Their natural enemies, especially small fishes, should be encouraged.

The most important insect enemies of the mosquito are displayed in WALL CASE 8, and in WALL CASE 6 is a group of fishes devouring their prey.

3. Destruction of adult mosquitoes by fumigating —

Cellars in which they hibernate and houses in which cases of malaria have occurred should receive special attention.

4. Screening to keep mosquitoes away from malaria patients from whom infection may be derived and away from healthy persons whom they might infect.

In WALL CASE 7 is shown a screened hospital compartment, and a portable net for protection against mosquitoes.

When the use of screens is impracticable it is often possible to drive mosquitoes away by the use of repellants.

Samples of repellants are shown in WALL CASE 6.

The phenomenal success of the battle against mosquito-borne disease is discussed in the section on yellow fever.

YELLOW FEVER

Yellow fever is a tropical disease, the cause of which was shrouded in mystery until the beginning of this century, when its connection with the mosquito was established.

CHARTS 16 and 17 show the place where the discovery was made, and the heroes who accomplished it.

The germ remains as yet undiscovered, but it is known to be carried by the *Aëdes* mosquito just as the malaria parasite is borne by the *Anopheles.*

Watercolor sketches of *Aëdes* will be found in CHART 15.

Aëdes, being an inhabitant of houses, breeds more often in vessels of stagnant water than in swamps and streams. It is fought by practically the same measures as *Anopheles*, though fumigation is more important than in the case of the malaria carrier. It is the common practice in Panama to fumigate an entire house in which a case of yellow fever has occurred.

Such a scene is shown in WALL CASE 7.

The wonderful success of the battle against mosquito-borne disease is nowhere better illustrated than in the history of the Panama Canal.

CHART 21 is a view of part of the completed Canal.

Our country was not the first to attempt this enterprise but it was the first to cope with the mosquito, and hence to succeed in building the canal.

In WALL CASE 7 are shown a French and an American hospital at Panama. The difference explains why France failed and America built the Canal.

Without the sanitarian, the engineer was helpless; with him the greatest engineering feat in history was accomplished.

These facts are presented to the eye by a series of models on the middle shelf. A chart at the top gives the drop in death rate resulting from the anti-mosquito campaign, and CHART 14 is a picture of the man who directed the work.

Many other plague spots have been cleaned up by the same means, and other projects than the great Canal have been made possible by war on the deadly mosquito.

CHART 22 and a chart in the bottom of WALL CASE 7 give the results of sanitary work in Havana.
A map in WALL CASE 7 and a model just beneath it illustrate one such instance.

SLEEPING SICKNESS

Sleeping sickness is a disease of man which has caused enormous fatality in Africa.

In WALL CASE 10 will be found a picture of a sufferer and near it a map showing the distribution of the disease.

It is produced by minute parasites called Trypanosomes, which live and multiply in the blood.

In WALL CASE 9 is an enlarged glass model of the parasite, and in WALL CASE 10 a photomicrograph of the organisms in the blood.

Various species of these parasites cause a number of tropical diseases of man and animals.

The organisms are spread by the biting tsetse-fly (*Glossina*) which inhabits dense wet places.

Specimens of the insect and pictures of its native haunts are in WALL CASE 10.

Sleeping sickness is sometimes treated by drugs.

A sample of Atoxyl (the drug used) is shown.

Our best means of fighting the disease is by controlling the insect-carrier. The most effective control measures are:

CHART 26 summarizes the control measures.

1. Prevention of fly breeding by removal of sheltering bush.

A model in WALL CASE 10 helps to visualize this process.

2. Control of infected human beings and animals so that flies may not acquire infection. Inspection and quarantine will accomplish this.

Another model shows a quarantine camp.

3. Protection of healthy persons against fly bites. Proper clothing and screening and avoidance of dangerous localities are the means.

Marked success has attended the fight against the tsetse-fly.

A small chart gives the drop in death rate in one instance.

OTHER INSECT-BORNE DISEASES

There are a great number of other diseases which depend for their existence upon insect-carriers. A few of these are treated in the Public Health exhibits.

Diseases of Man: Typhus fever is a disease which was once very prevalent in army camps. It is caused by a parasite which is transmitted by the bite of the body louse.

A large wax model of the body louse will be found in a case at the entrance to the Hall, and specimens of it are in WINDOW CASE 3.

Modern sanitary methods have brought it largely under control.

The upper shelf of WALL CASE 10 is devoted to typhus control, and a chart in the center indicates the effectiveness of the campaign.

Relapsing fever is a tropical disease carried by ticks and caused by a blood parasite (*Spirochæta*).

A glass model of a Spirochæta will be found among the blood parasites in WALL CASE 9.

Owing to social conditions in the tropics, control is difficult, and the method most often employed is the destruction of the infected dwellings.

A model at the right of the bottom in WALL CASE 10 depicts such a scene.

Elephantiasis is another tropical disease caused by a relatively large, worm-like parasite called *Filaria*. This animal obstructs the blood vessels, causing an enlargement of some extremity.

See model in WALL CASE 9.

In WALL CASE 10 is a picture of a person so afflicted.

Mosquitoes of the genus *Culex* carry the young parasites from diseased to healthy persons.

Chagas fever is a disease of children in Brazil, which is carried by the bites of certain bugs.

Specimens of these bugs are shown in WALL CASE 10.

Diseases of Cattle: Cattle are frequently sufferers from the ravages of blood parasites of which little is known save that ticks are the sole carriers.

In WALL CASE 10 are specimens of the principal offending ticks and a piece of cowhide which tells the story of the creature's abundance.

The diseases are very serious in some parts of the United States and are responsible for great financial loss to the country.

CHART 25 gives the distribution of the disease, and in CASE 10 is a picture of Bitter Root Valley, where a human tick-borne disease, Rocky Mountain Spotted Fever, has prevailed.

The most effective means of control is the frequent treatment of cattle with poisonous washes. Arsenic solutions— the poison most used — may be applied by immersion or by spraying.

The right of the middle shelf of WALL CASE 10 is devoted to the various devices used by cattle raisers for the protection of their stock.

THE FLY

A great many species of flies are found in houses, but the preponderant type is the well-known House Fly (*Musca domestica*). This insect is our commonest and most dangerous household pest.

Just above CHART 33 will be found specimens of some of the commonest species of flies, and CHARTS 28 and 33 include enlarged drawings of them.

In a case at the entrance to the Hall is a huge model of the House Fly. In WALL CASE 11 a series of four jars illustrates the fly's life cycle, while charts give the time required at various temperatures for the complete transformation and the relative importance of various breeding substances. A jar on the bottom shelf shows the number of flies found breeding in a pound of manure. CHART 32 shows two typical breeding places.

During its life the fly passes through four stages: egg, larva, pupa and adult.

The eggs are laid by the female in filth of some sort — preferably in horse manure, but frequently in human excreta.

The larva or maggot, hatching from the egg, feeds upon this substance and grows to a length of perhaps half an inch, when it burrows down to a dry place and, upon casting its skin, becomes a dormant pupa. From this pupa the adult fly emerges, to wing its way from filth to our food.

As each female lays an average of one hundred and twenty eggs, and as nine generations are possible in one season, a single female may, under ideal conditions, be responsible for several hundred trillion offspring.

This fact is illustrated by four jars and a picture on the top shelf of WALL CASE 11.

As a result of its nasty habits, the fly is a germ-laden creature.

Several culture plates in the same case show the bacteria which developed in the tracks of a fly, and tubes of sand represent the number of bacteria washed from flies. CHART 31 shows a much enlarged fly foot with disease bacteria clinging to it.

If it has access to human discharge and then to food the fly may become a disease bearer. The fly was largely responsible for typhoid fever during the Spanish-American War, while it has been suspected of causing epidemics in times of peace. It has been shown that infants in fly-infested houses of New York City are visited by two and a half times as much summer complaint as those in clean homes.

See a model in WALL CASE 11 (top shelf, right) and a small map at the extreme left.

A model in the center of the same case illustrates this fact.

Such conditions as these demonstrate the necessity of ridding ourselves of the fly. This is best done by the following means:

For summary see CHART 29.

1 Prevention of fly breeding:
All manure should be either covered or disinfected.
Exposed refuse should be cleaned up. Maggots may be destroyed in a maggot trap. The fly's natural enemies should be encouraged.

A covered manure bin and samples of borax and hellebore for disinfecting manure are shown.

One such trap is exhibited.
The most important fly enemies are grouped in WALL CASE 12.

2. Destruction of adult flies:
They should be trapped or killed with fly-paper, fly-poison and the swatter.

A good fly-trap is shown in WALL CASE 11,

3. Guarding human excreta against access of flies:
Flies cannot carry typhoid from a properly screened and enclosed privy.

and on the shelf above are two types of safe privies explained by models.

4. Keeping flies out of houses and away from food:
A screened window in summer may be valuable health insurance. The storekeeper who does not protect his foods from flies is your enemy.

Facts and figures have shown that war on the fly is worth while.

CHART 34 shows the effect of the application of control measures.

THE HOUSE FLY OR TYPHOID FLY

One of the Exhibits in the Hall of Public Health

AMERICAN MUSEUM OF NATURAL HISTORY

PERUVIAN ART

A HELP FOR STUDENTS OF DESIGN

By CHARLES W. MEAD

GUIDE LEAFLET No. 46

SECOND EDITION

POTTERY VESSELS FROM NAZCA, PERU

PERUVIAN ART

AS SHOWN ON

TEXTILES AND POTTERY

BY

CHARLES W. MEAD

SECOND, ENLARGED EDITION

The American Museum of Natural History

GUIDE LEAFLET No. 46

New York, April, 1919

PRINTED AT THE MUSEUM

PERUVIAN ART

A Help for Students of Design

By CHARLES W MEAD

Assistant Curator, Department of Anthropology

INTRODUCTION

The Museum's collections of textiles and pottery vessels from prehistoric graves in Peru provide an opportunity for the study of primitive art that is not excelled, if, indeed, it is equaled in any other field. The great beauty of the color schemes and the wonderful number of curious conventionalized animal figures, especially in the textiles, make these exhibits particularly valuable to the student of design. That this opportunity exists and that the Museum authorities as a part of their educational system are providing all the assistance and comfort possible to visiting artists and students are fast becoming known, as shown by the fact that for quite a number of years an average of one hundred and fifty a month have availed themselves of this privilege, while during the last two years that number has been doubled.

As a large part of the students of design who make use of these textiles expect later to obtain positions in textile houses, carpet, rug, or wall paper manufactories, or to enter into some other business where designers are employed, it will interest and encourage them to know that many textile houses have lately put upon the market silks and other materials decorated with designs inspired by the figures and color schemes of the prehistoric Peruvians. Our large textile manufacturers have, year after year, sent their best artists to Paris for designs, having no idea that such a wealth of material, eminently suitable for decoration, was waiting for them in the Museum so near at hand.

During the past year a number of these textile manufacturers have visited the Museum and have become aware of the existence of these collections. Having once seen them they were by no means slow in recognizing their value and in sending their artists to copy the color schemes and create designs from the decorative figures of the ancient Peruvians. Having satisfied themselves of the commercial value of the Peruvian collections to them, they naturally began to look about for the decorative work of other primitive peoples and to-day their designers may be seen at work in many of the Museum halls.

In a Guide Leaflet it will not be possible to go far in the peculiar art of the Peruvians, and but comparatively few of the innumerable designs can be shown. Their color schemes, which excite the wonder and admiration of artists, must be seen on the original webs, but enough designs can be reproduced to show the general character of this side of their art.

It always gives an added zest to the work when we know something about the material from which we are drawing and for this reason it will not be out of place to say a few words about the history of these cloths. They all come from prehistoric graves; many of them were found still on the mummies when the burial places were excavated. A greater part of them came from the coast region which is a desert tract except for the valleys of the small rivers rising in the cordillera and flowing into the Pacific Ocean. These valleys were very fertile and there the people lived and buried their dead in the dry nitrous sand outside. Rain is all but unknown in this region, which accounts for the wonderful state of preservation in which these webs have come down to us.

The first question that naturally suggests itself to the visitor is—How old are these things? This question cannot be definitely answered. All that can be said is that they antedate the Conquest (1532); that they belong to different epochs, and that the oldest in all probability date back several thousand years. In two papers published by the Museum, my associate, Mr. M. D. C. Crawford, has given the results of his studies in the technique of Peruvian textiles. To these anyone interested in that subject is referred.[1]

It is a very common mistake to speak of such a collection of Peruvian textiles as the work of the Incas, for by far the greater part of them were made by the so-called Megalithic people who ruled the country many centuries before the rise of the Inca empire.

Four motives continually occur in Peruvian decorations: the human figure, the bird, the fish, and the puma. These were everywhere employed throughout the country in designs which varied somewhat in the different localities, showing that their arts had developed along slightly different lines.

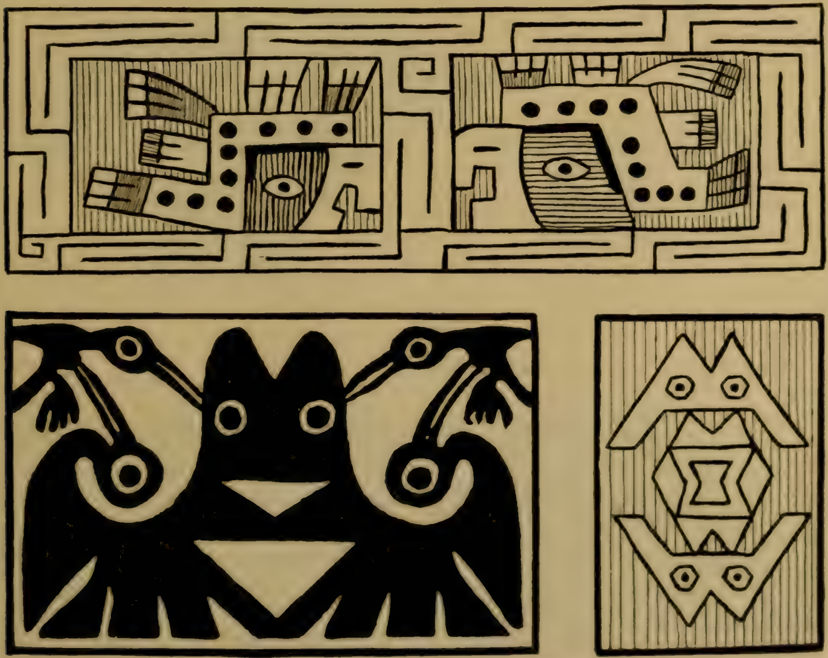
In studying the designs more space will be given to the figures derived from the fish than to those from the other motives. The reason

[1] Anthropological Papers of the American Museum of Natural History, Vol. 12, Parts 3–4.

for this is that the designs from the other three motives very rarely show degeneration to the extent that their identity is not apparent, while many of the fish figures have progressed so far that to recognize the motive one must be familiar with some of the stages through which it had passed in reaching its present form.

The writer does not wish to convey the idea that degeneration of any animal form constantly progressed, step by step, at every repetition losing a little more of its realistic appearance until its character could not be recognized. A series of figures could be selected from the vast number at our command that would apparently show such progression and this has often been done for the primitive art of other localities, but this method is very misleading, as the higher conventionalized forms were undoubtedly reached by mutations instead of steady progressions.

Many of the sketches on the Plates of this Leaflet were made at various times during the past fifteen years for various papers, illustrated catalogue cards, and other purposes. Every design shown will be found in the exhibition cases in the South American Hall.



MISCELLANEOUS PERUVIAN DESIGNS

PLATE I

THE FISH

THE FISH

Plate I

The Peruvians of the coast region worshipped the sea as one of their gods and the fish, being the natural emblem of the sea, undoubtedly accounts for the frequency with which it appears in all their arts. We find it woven, embroidered, and painted on cloth; molded, incised, and painted on pottery; and represented in various ways on their works in metal, wood, stone, and bone. I shall show some of the conventionalized figures that plainly represent fish; others that I have found, during my long experience with art students, where the fish motive is very rarely suspected, and some intermediate figures that I believe will enable the student to recognize this motive in the higher forms of Peruvian art. The first three figures on this Plate plainly represent fish, although degeneration has made considerable progress. They are shown as if seen from above, a common way of representing fish with many primitive peoples.

Fig. 1 is painted on a large piece of cloth which formed the outer wrapping of a mummy bundle from Surco. It is painted in black except the curved line representing the gill openings and the fins. The six small squares show the dorsal fin.

Fig. 2 is a very common form, in fact the typical Peruvian fish. If we study carefully all the forms on Plates I and II we shall find that the greater part of them are but modifications of this figure. We shall find the number of points projecting from the sides more or less, or two fish derived from this form interlocked, as shown in Fig. 7.

Fig. 3 is from the wrapping of a mummy bundle found in the vicinity of Lima. The lines representing gill openings are straight in this case. The characteristic projecting points from the sides are present.

Fig. 4 is a design not uncommon in tapestry from the coast region in the vicinity of Lima. It consists of four fish heads, in colors, surrounding a fret. During the many years that design students have worked from these Peruvian collections, I do not remember a single case in which the fish motive was suspected in this figure until I had made it clear by drawing the forms shown in Figs. 5 and 6. The character of such a design when it is woven in the cloth, in a variety of colors, is by no means as easily recognized as when drawn on paper in black and white.

PLATE II

THE FISH

Figs. 5–6. Fig. 5 is a tracing of the upper fish head in Fig. 4. Fig. 6 was made from the same tracing, but in inking it, straight lines down from the mouth were substituted for the step-form ones of Fig. 5, and this gives us exactly the same head as seen in the fish form at Fig. 2. These step-form lines, caused by the technique of weaving, often disguise a form that would be obvious if the lines were straight.

Fig. 7 shows the interlocked fish design, a form of decoration very common over most of the coast region, where it is found on borders of ponchos, belts, etc. In the poncho border from which this figure was taken the decoration is in diagonal bands, each band having two colors. The black fish shown is interlocked with one in red. The bands on either side are in different colors. A repetition of the same figure, but in different colors, arranged either in rows or, as in this illustration, in diagonal bands, is a prominent characteristic of Peruvian art. If we examine any one of these fish we find that such parts of it as can be seen when another is interlocked with it are like the typical one shown in Fig. 2.

THE FISH

Plate II

Fig. 1 gives us another form of the interlocked fish design. We see here attached to the tail of each fish a form bounded on one side by a straight line and on the other by a zigzag forming four chevrons or points. This added figure plays quite a part in Peruvian art, as we shall see when we come to discuss their bird forms.

Fig. 2 was traced from the black fish above. If two forms like this are cut from paper, and one of them colored black, they will, on being put together, give the design shown. This form is often found and sometimes a bird head takes the place of the half of a fish head shown here. On turning back to Plate I and looking at the typical fish in Fig. 2 we find that one is but a skeleton or part of the other.

Fig. 3 is also a part of the design above, and is frequently used in decoration just as it is shown here.

Fig. 4 is an example of their work in pyrography. This design was burned into the side of a gourd bowl. The figure spoken of before: one bounded on one side by a straight line and on the other by a zigzag, forms all but the head of this highly conventionalized fish. It varies

but little from those shown in Figs. 3 and 6, and has the triangular head of Fig. 10. Triangular heads are very common in cloth and on pottery fish forms.

Fig. 5 is another variation in the interlocked fish pattern. As the heads, tails, and crude outlines of the bodies of fish, as the Peruvians represented them, are shown, there has never been any trouble about identifying the true motive.

Figs. 6 and 7 are in relief on pottery vessels. They show again the fondness of the Peruvians for the interlocked design. In Fig. 6 each fish is the same as Fig. 3, which has an extra projecting point. The number of points in the body of a fish or bird was governed entirely by the space to be filled up by the decoration. In Fig. 7 degeneration has not progressed as far as in most of the other figures and the motive is apparent.

Figs. 8–10 are forms common on pottery vessels, sometimes painted, but oftener incised or in relief.

Fig. 11 shows the designs on a tapestry belt. It is very common on the small bags that may have been used as charms. This fish head varies but slightly from that shown in Plate I, Fig. 4, and the means shown there of identification apply equally to this form and its many variants.

Fig. 12 has been identified as the horse mackerel and is a fairly realistic representation of that fish. It is painted in several colors on a pottery vessel from Nazca.

Fig. 13 is cut from a thin sheet of silver. Twenty of these fish are fastened on a cord in the form of a necklace. It comes from Ica, but such fish strung together or with beads were common in many places in the coast region.

The forms shown in Figs. 14–16 represent the shark and are found both on cloth and on pottery vessels.

Fig. 17 is in relief on a pottery vessel from Surco. It is a very common fish form over all the coast region. The original of this sketch is 9 cm. long, and it is often seen very much larger both on cloth and pottery.

Figs. 18–19 are from Nazca pottery. Both show a parallel line of white which in the first case completely separates the body into two unequal parts. Whether this represents the median line or was only a fancy of the artist must be left to guesswork.

In Fig. 18 there is an idea for the design student. In the original the two parts are in different colors, with the line of white between them. This will suggest to the design student the breaking up of any of the other figures and using the parts so obtained in his work.

THE BIRD

Plate III

Figs. 1–8 and 11 are from the coast region in the vicinity of Lima. Figs. 1–2 show the typical bird of Peruvian cloth. The heads and necks are fairly realistic. The body consists of the form mentioned in the remarks on the interlocked fish design, Plate II, Fig. 1. As was said, this consists of a figure bounded on one side by a straight line, and on the other by a zigzag which forms chevrons or points. The number of points, or length of the body, depends entirely on the space to be decorated.

Fig. 3. The head is more realistic than in the two preceding figures, but the body is represented in the same way. In the original the space between the head and the body is nearly filled by the head of a second bird, turned in the opposite direction, the two forming an interlocked bird design.

Fig. 4 is from the border of a tapestry poncho, where the decoration consists of a long line of these birds. Each figure is woven in several colors, and they are so placed that two with the same color scheme do not come together. Note the exaggerated topknot projecting over the bird's head. This device makes the whole figure nearly rectangular, and in a row of such designs little space will be left undecorated.

Fig. 5 is painted on white cloth. The heavy outline is black, the body brown, and the eye and space between the mandibles were left white.

Fig. 6. Here again the artist resorted to the same device as is shown in Fig. 4. He has used an exaggerated topknot to balance his designs and cover space.

Fig. 7. In this case the wings have been carried over the head and made to serve as quite a part of the design.

Fig. 8 shows a common bird form in textiles. It will be seen that this is very closely related to the form in Fig. 2. If we substitute the legs in this for one of the points in the body of that one, we shall have practically the same design.

PLATE III

THE BIRD

Fig. 9 represents a humming bird. A row of these birds is painted around a pottery vessel from Nazca. They are all sucking honey from a six-pointed flower on the upper surface of the vessel. Only a part of this flower is shown in the sketch.

Fig. 10 shows another bird on Nazca pottery. This, like the last described, is beautifully painted in colors.

Fig. 11 is a pelican that has just caught a fish. This design is a part of the woven fabric. Similar figures are also found in relief on cloth. This is done by sewing on narrow pieces of braid. The fish in the bird's mandibles is a common conventionalized form, often seen both on cloth and pottery, especially where space only admits of a small figure.

Fig. 12 shows birds from three Nazca pottery vessels. They are painted white on variously colored darker backgrounds.

Fig. 13 shows the decorations on a piece of vicuña cloth, as it is commonly called, from Pachacamac. The warp threads are cotton, crossed by a weft of vicuña wool, which completely covers them. The ground color is a deep reddish-brown with the decoration in yellow. The effect produced is extremely pleasant and artistic and has made this textile one of the favorites of art students who have many times copied it in colors. It also affords a good example of the influence of basket work on the arts of these people. The lines bounded by zigzags are plainly copied from the work of the basket maker. The birds' necks rise and depend from these basket designs.

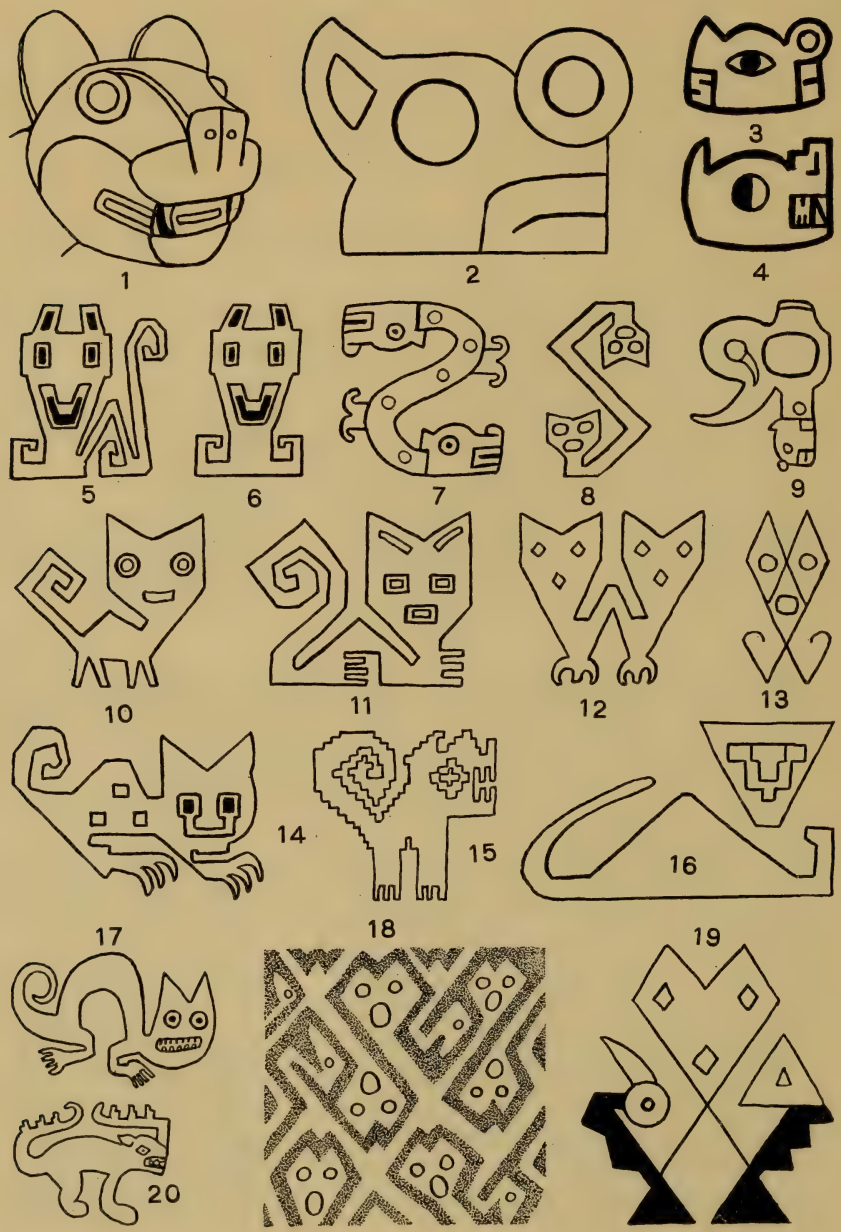
Fig. 14 is from a large shawl-like garment from Lachay, near Chancay. The color of this textile is indigo blue with the designs woven in white, in broad stripes. It is the interlocked bird design: the upper bird faces to the right, and the lower one to the left. If we study one of these birds we find in its neck and body the same form as is shown in Fig. 3.

THE PUMA

Plate IV

Fig. 1 shows the head of the puma in terra cotta. This form is only found in the art of Tiahuanaco. It seems to be the parent of the hundreds of conventionalized cat heads wherever the influence of Tiahuanaco art is found and especially at Pachacamac. The puma was one of the gods worshipped by the Peruvians and the "puma god," part man and part puma, is often represented in the arts of the Tiahuanaco or Megalithic people.

PLATE IV



THE PUMA

Fig. 2. The central figure on the monolithic gateway at Tiahuanaco is represented as wearing a belt with this form of puma head on either end of it. A great number of variants of this head are common to Tiahuanaco art and wherever its influence extended.

Figs. 3–4 are plainly derived from the preceding figure. Fig. 3, from Pachacamac, has the ring nose. Fig. 4, from Nazca, has a step-form nose in place of the ring. There is a close similarity in the outlines of these figures. We shall find other variations on this head in Figs. 7, 9, and 15.

Figs. 5–6. These two figures will show, to a person who has no knowledge of primitive art, one way in which animal figures degenerate. It would be very excusable if such a person did not recognize Fig. 6 as a great cat. In fact, a positive identification could not be made by anyone who had not seen the same form of the animal before the degeneration had proceeded to the extent shown here. Now, looking at Fig. 5, we recognize that it shows the same animal in a more realistic form. It is still highly conventionalized, but the presence of the humped-up back, a characteristic of the cat family, and the tail, both omitted in Fig. 6, clearly identify it. To identify many highly conventionalized representations of animals in any primitive art, one must be long associated with large collections, which are seldom to be found except in museums. Only in this way can he become familiar with the peculiar art of a primitive people. He sees the animal forms represented with considerable truth to nature, and also a long succession of figures where, as it were, the original form is gradually fading away, until the degeneration has run its full course and left little more than a geometrical figure.

Figs. 7–8. The Peruvians had a fondness for combining a number of animal heads in a design. Sometimes heads of the same animal, but often of two or more different kinds, were thus combined. Fig. 7 shows two puma heads joined by a curved band. The design is painted on a pottery vessel from Pachacamac. On account of the form of the band that connects the heads, this figure has sometimes been mistaken for a representation of a serpent, but a comparison of one of the heads with the four puma heads on the line above will show its true character. Fig. 8, on a web from Ancon, has the typical cat heads connected by an angular band.

Fig. 9 shows part of a human face engraved on a piece of a stone vessel from Tiahuanaco. One eye is represented with the facial decora-

tion about it. The other eye is similarly decorated. The puma head below the eye plainly belongs to the same animal, as do those in Figs. 2 and 3.

Figs. 10 to 20 are from the coast region, within fifty miles of Lima.

Figs. 10–11 are very common in tapestry. Both have the raised back, a characteristic of the cat family.

Fig. 12 is another example of their fondness for joining animal forms together in a design. The two cats have the humped-up back in common.

Fig. 13 is common on cloth, pottery, gourds, and on metal objects. A comparison of this figure with that in Fig. 6 shows a great similarity in the management of the legs. Doubtless some ancestor of this design has the raised back and tail that we have seen to have been the case with the other figure.

Fig. 14 is from a piece of tapestry from Ancon. The most noticeable thing about this figure is the manner of representing the nose, eyes, and mouth. The technique of weaving seems to have been responsible for this form, as Hasluck shows the same device in a lion woven in a goat-hair carpet of the fifteenth century from Persia.[1] Certainly no one will claim contact between the prehistoric Peruvians and Persians.

Fig. 15. This design is taken from a coca bag from Pachacamac. It is in the style of Tiahuanaco.

Fig. 16 is from a long belt or sash. It is the most highly conventionalized design on this Plate, but the characteristics of the cat family, the raised back and tail, are still present.

Fig. 17 is painted on either end of a barrel-shaped vessel from Ica.

Fig. 18 was taken from a textile from Ancon. The design is made up of cat and bird heads. Their fondness for joining different animals together in a design has been spoken of before. It is not uncommon to find birds, cats, and fish in the same design.

Fig. 19 is from a gourd bowl from Marquez, near Lima. The design is burned into the side of the vessel. Pyrography was commonly used in decorating these gourds. This design shows three motives, cat, bird, and fish. There has never been any difficulty in recognizing the cat and bird, but in my experience few students see the fish motive in this

[1] Decorative Designs of all Ages for all Purposes. London, Paris, New York, Toronto, and Melbourne, 1808, p. 128.

figure until their attention is called to other designs where practically the same form of fish is shown, but under conditions that make its true nature more apparent. See Figs. 1–3 on Plate II.

Fig. 20 is found both on cloth and pottery, in the coast region.

MAN AND MYTHOLOGICAL CHARACTERS

Plate V

Fig. 1 is from tapestry from Surco.

Fig. 2 was taken from a long cotton belt from Chancay.

Fig. 3 shows a woven tapestry design from Pachacamac. It is in the Tiahuanaco style and probably represents the puma god. Their fondness for combining different animal figures has been spoken of. Note near the bottom, to the right, the bird head and neck, and to the left of it a puma head with its ring nose. Compare this head with those on Plate IV, Figs. 2, 3, 4, and 9.

Fig. 4. This conventionalized human figure is common in many parts of Peru. The head occupies the center of the design, and the arms and legs have degenerated into scrolls.

Figs. 5–6 are painted on Nazca pottery.

Fig. 7. In this design the man's headdress, arms, and legs have turned into frets.

Figs. 8–9 are from painted decorations on Nazca pottery. Fig. 8 shows a face very common on vessels from that locality, especially on the tall, cylindrical ones.

Fig. 10 shows a human head with feather headdress. This form of representing feathers is common all over the coast region. It is painted on a pottery vessel from Pachacamac.

Fig. 11, also from Pachacamac pottery, needs no comment.

Fig. 12 is woven in a web from Ancon. It shows a headdress of two feathers and has the ear represented in a curious way that seems to be peculiar to Peruvian art. We find this same ear in animal figures. See the puma head at the lower part of Fig. 3 on this Plate. Dr. Arthur Baessler has commented at some length on this subject, and styles this figure "a misdrawn ear."[1]

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[1] Ancient Peruvian Art, Ed. A. H. Keane. Description of Plates 136–139. New York, 1902–1903.

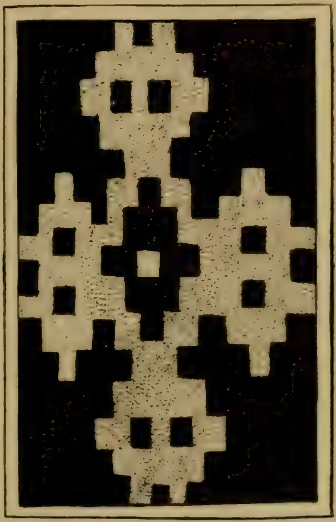
PLATE V

MAN AND MYTHOLOGICAL CHARACTERS

Figs. 13–14 show faces painted on Nazca pottery.

Figs. 15–17. We have here three mythological characters of the pre-Incan people. They occur in many localities, with such local variations as we should naturally expect them to show. The first is part bird and part man; the second, part fish and part man; and the third, part cat and part man. They are known respectively as the condor god, the fish god, and the puma god. They are taken from painted representations on pottery. Fig. 15 is from Pachacamac. Fig. 16 is common in the coast region, and is often represented as chasing two men in a balsa. Fig. 17 is from Nazca.

Figs. 18–24 show various designs from the human head and form which I have copied from painted decorations on Nazca pottery.



MISCELLANEOUS PERUVIAN DESIGNS

PLATE VI

MISCELLANEOUS PERUVIAN DESIGNS

PLATE VII

MISCELLANEOUS PERUVIAN DESIGNS

PLATE VIII

MISCELLANEOUS PERUVIAN DESIGNS

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AMERICAN MUSEUM OF NATURAL HISTORY

GENERAL GUIDE

TO THE

EXHIBITION HALLS

EDITED BY

FREDERIC A. LUCAS

GUIDE LEAFLET SERIES No. 47

The American Museum of Natural History

THE AMERICAN MUSEUM OF NATURAL HISTORY

South Facade, Facing Seventy-seventh Street

The cornerstone of the Museum, which is intended to occupy all of Manhattan Square, was laid by General Grant in 1874. The material of the building is red granite, part from Nova Scotia and part from Texas. The portion completed is about one-third of the Museum as planned, and each façade is to be, like the present, 710 feet long, the most important architecturally to be that fronting Central Park. The total floor area of the present structure is more than ten acres, and the total cost $5,318,820.94.

GENERAL GUIDE

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EXHIBITION HALLS

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BY

FREDERIC A. LUCAS, Director

Assisted by Members of the Museum Staff

THE AMERICAN MUSEUM OF NATURAL HISTORY
SCIENCE EDUCATION

GUIDE LEAFLET SERIES No. 47

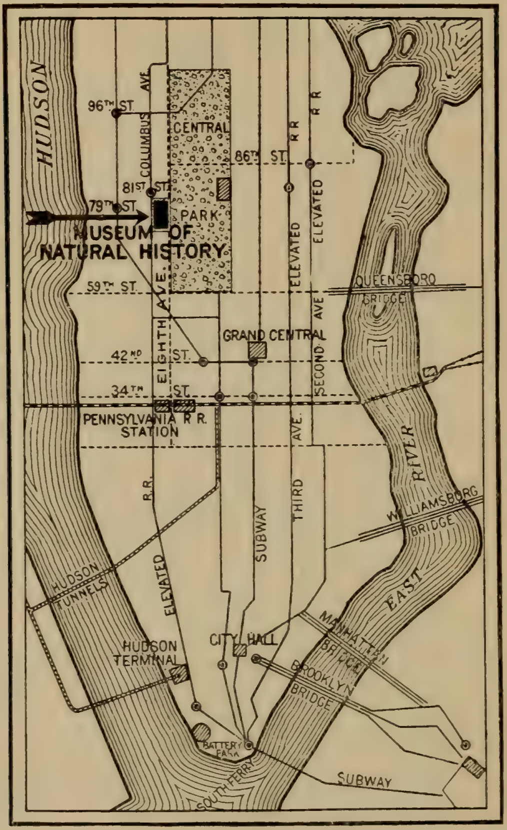
New York

Published by the Museum

January, 1918

HOW TO REACH THE MUSEUM

The Museum is located at 77th Street and Central Park West, and can be reached by the 8th or 9th Avenue surface cars, the 6th or 9th Avenue elevated to 81st Street station, or by the subway to 72nd or 79th Street station. The Museum is open free every day in the year; on week days, including holidays, from 9 A. M. to 5 P. M., on Sundays from 1 to 5 P. M.



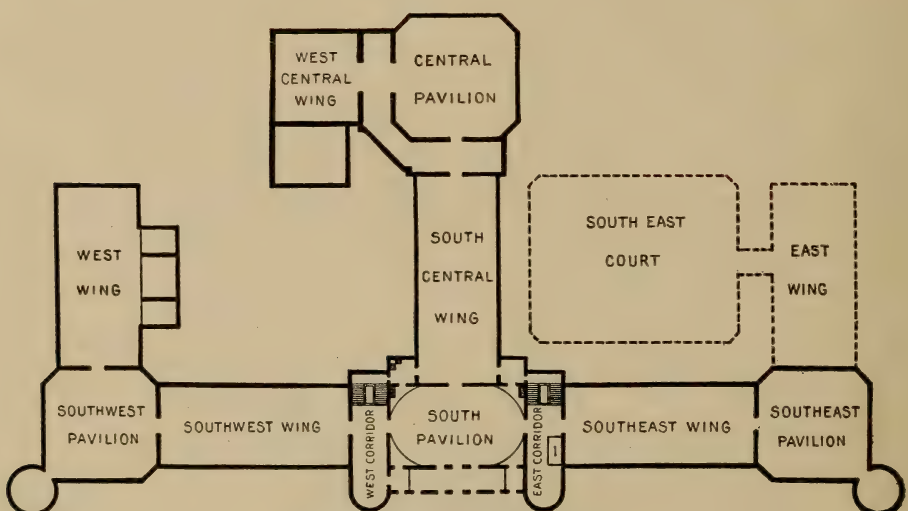
From the Grand Central Station take Subway Local to 79th Street.

From the Pennsylvania Station take the Eighth Avenue surface cars.

CONTENTS

PREFATORY NOTE

It is frequently necessary to rearrange the exhibits in order to provide space for new material or to put into effect advanced ideas regarding methods of exhibition, and as these changes are taking place all the time, it unavoidably happens that now and then discrepancies will be found between the actual arrangement of the specimens and that noted in the GUIDE. In some cases further information may be obtained from the GUIDE LEAFLETS which describe exhibits of special interest. See list of Popular Publications.



FLOOR PLAN OF THE MUSEUM

Showing the location of the halls and the names by which they are designated in this Guide. See Key to Exhibition Halls on opposite page.

The halls are named according to the position they will have in the completed Museum building, which will consist of four long façades, facing east, west, north and south respectively, each connected with the center of the quadrangle formed by a wing extending between open courts. Thus the hall at the eastern end of the south façade (the only façade completed) becomes the "southeast pavilion."

KEY TO EXHIBITION HALLS

See Floor Plan on Opposite Page

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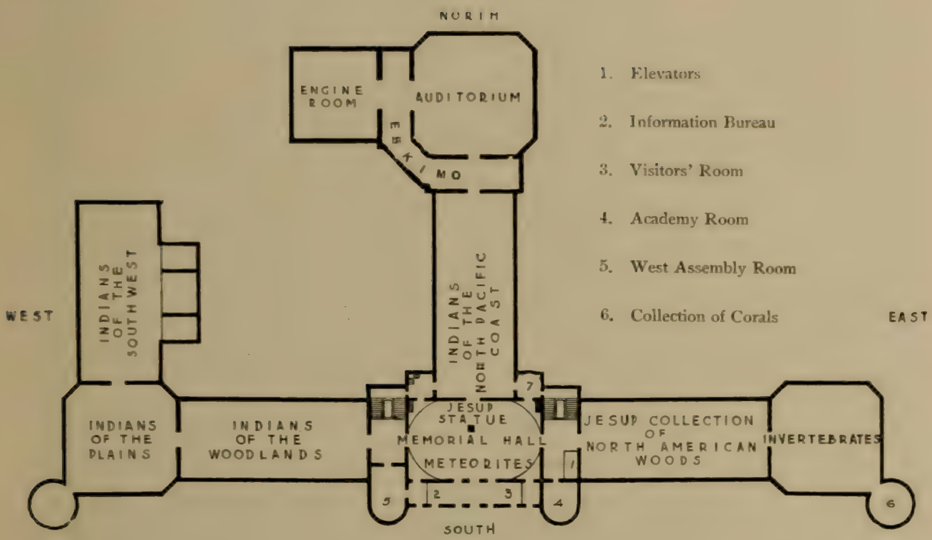
MEMORIAL STATUE OF MORRIS K. JESUP

Mr. Jesup, President of the American Museum of Natural History for more than a quarter of a century, was a staunch supporter of the institution's two aims: to be a great educational institution for the people and also a center for activity in scientific research.



South Pavilion

MEMORIAL HALL

Bench Mark

Before entering the Museum one notices the "Bench Mark" established by the U. S. Geological Survey in 1911 on which is inscribed the latitude and longitude, 40° 46′ 47.17″ N., 73° 58′ 41″ W., and height above sea level, 86 feet.

Glacial Pothole

On the right is a "pothole" from Russell, St. Lawrence Co., N. Y., formed by an eddy in the waters of a stream beneath the melting ice of the glacier that covered Northern New York. The stream carried pebbles that, whirled around by the eddy, cut and ground this hole, which is two feet across and four feet deep.

Glacial Grooves

On the left is a large slab of fossiliferous limestone from Kelleys Island in Lake Erie near Sandusky, whose surface has been smoothed, grooved and scratched by the stones and sand in the bottom of the vast moving ice sheet or glacier that covered the northeastern part of North America during the Glacial Epoch.

Visitors' Room

The *Information Bureau* and the *Visitors' Room* are on either side of the south entrance. Wheel chairs for children or adults are available without charge. Postcards, photographs, guide leaflets, and Museum publications of various sorts are for sale, and visitors may arrange to meet friends here. On the right and left of the entrance are small *Assembly Halls* in which lectures to classes from the public schools of the City are given and where the New York Academy of Sciences and other scientific societies hold their meetings.

MEMORIAL HALL

During the Exhibition of the Horticultural Society in 1916

From the lobby the visitor first enters *Memorial Hall* and faces the marble statue of Morris K. Jesup, third President of the Museum. Mr. Jesup was a founder, trustee and benefactor of the Museum and for twenty-seven years its President. Under his administration and through his liberality the Museum made rapid progress. This statue of Mr. Jesup was executed by William Couper and was presented to the Museum by the Trustees and a few other friends. The marble busts in the wall niches represent noteworthy pioneers of American science, and are the gift of Morris K. Jesup. These include Benjamin Franklin, statesman and natural philosopher, Alexander von Humboldt, geographer and geologist, Louis Agassiz, zoölogist, Joseph Henry, physicist, John James Audubon, ornithologist, Spencer Fullerton Baird, zoölogist and founder of the United States Fish Commission, James Dwight Dana, geologist, John Torrey, botanist, Edward Drinker Cope, paleontologist, Joseph Leidy, anatomist, and Robert E. Peary, explorer.

Statue of Morris K. Jesup

Memorial Hall was once the lecture hall and here thousands have listened to Professor Bickmore.

Circling this same hall is a portion of the collection of meteorites, popularly known as "shooting stars," ranging in weight from a few pounds to 36 tons. The greater number of meteorites are stony, but the more interesting ones are composed chiefly of iron, while certain meteorites contain both stone and iron. The toughness of iron meteorites is due to the presence of nickel, and the fact that they were so difficult to cut led to the adoption of an alloy of nickel and iron in making the armor plate for battleships. Meteorites have a very definite structure and when polished (see specimens on the right with electric lamp) show characteristic lines which together with their composition are to the expert absolute proof that the specimens are meteorites.

Meteorites

"Ahnighito" or "The Tent" at the left is the largest known meteorite in the world and was brought from Cape York, Greenland, by Admiral R. E. Peary. It weighs 36 tons, and its transportation to New York was an engineering feat. Opposite it at the right is the curiously pitted "Willamette" meteorite from Oregon which was the subject of a famous lawsuit. The smaller meteorites will be found in the Hall of Geology, fourth floor. [The collection of meteorites is described in *Guide Leaflet* No. 26.]

Ahnighito Meteorite

Willamette Meteorite

Jadeite Boulder

Here too is a polished boulder of jade, or jadeite, the second largest ever found.

WEAVING A CHILKAT BLANKET

One of the Mural Paintings of Will S. Taylor

South Central Wing

INDIANS OF THE NORTH PACIFIC COAST

Indians of British Columbia and Alaska

North of Memorial Hall—that is, to the rear of the Jesup statue—is the *North Pacific Hall*, where are displayed collections illustrating the culture of the Indians of the northwest coast of America. These collections are arranged geographically so that in passing from south to north through the hall the visitor meets with the tribes in the same sequence that he would in traveling up the west coast of North America.

Haida Canoe

The most striking object is the great Haida Canoe in the center of the hall. In it is being constructed a group representing a party of Chilkat Indians on the way to celebrate the rite of the "potlatch." The potlatch is the great "giving ceremony," common to all the coast tribes when individuals and families gladly impoverish themselves that the dead may be honored, and social standing of the clan or family recognized and increased. At the stern of the canoe, which is represented as approaching the beach, stands the chief or "medicineman," who directs the ceremony. The canoe is a huge dugout made from a single tree, is 64½ feet long and 8 feet wide and capable of carrying 40 men.

Totem Poles

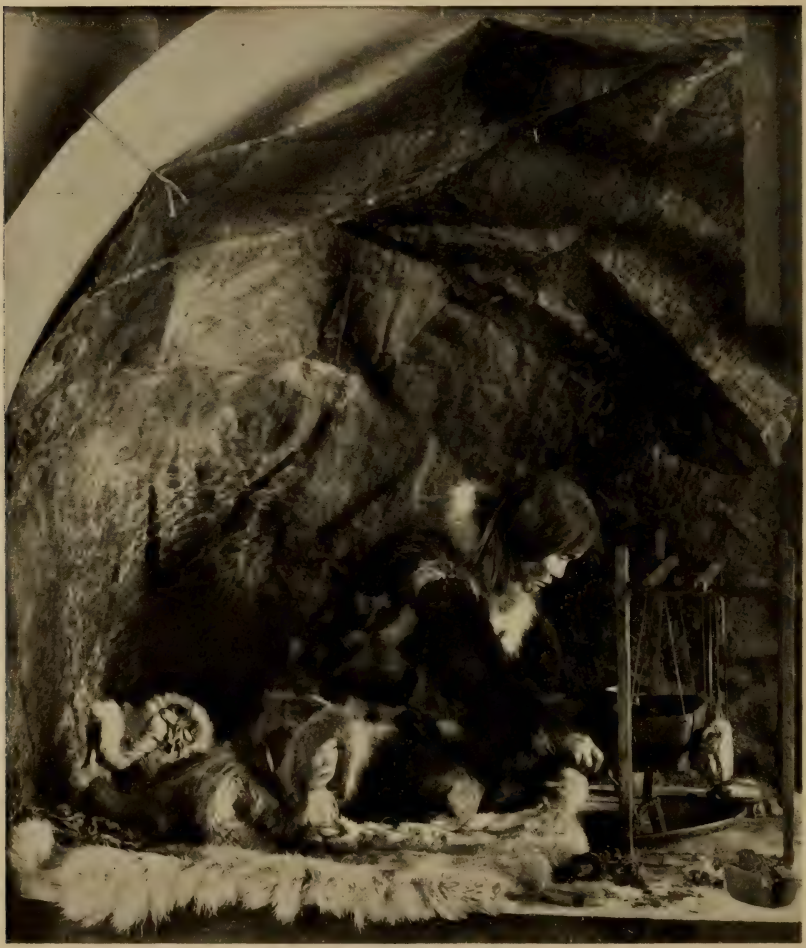
Against the pillars and walls of the hall are many house posts and totem poles with their grotesque carvings; the latter may represent either the coat of arms or family tree, or they may illustrate some story or legend connected with the family. The Haida Indians together with the Tlingit are recognized as superior in art to the other Indian tribes along the northwest coast of North America. They are divided into a number of families with various crests for each family and grouped in two main divisions, the Ravens and the Eagles. The Tlingit are makers of the famous Chilkat blankets, of which the Museum possesses an exceptionally fine collection.

Chilkat Blankets

Totem pole at Wrangel, Alaska. At the bottom is a beaver with a frog under his chin; above is a raven; and above the raven a frog, which is surmounted by a human head.

Among some of the other tribes there is little wool weaving, the clothing consisting of shredded and softened inner tree bark braided and matted together. The Indians of this region are preeminently a woodworking people, as is manifest in the exhibit. Religious ceremonies and the wearing of masks generally supposed to aid the shaman or priest in curing disease were customary among most of the tribes. The masks represented guardian spirits and by wearing them the shaman impersonated these spirits and assumed their powers in healing the sick or obtaining game.

Religious Ceremonies



ESKIMO HOME SCENE

There are two instructive groups near the entrance to the Auditorium. In one, a home scene within a snow house or "igloo," an Eskimo woman is cooking blubber over the flame from a seal-oil lamp; the other represents an Eskimo woman fishing through the ice. The Museum is rich in Eskimo collections.

Mural Decorations

The mural decorations by Will S. Taylor between the windows on both sides of the hall represent the industries and ceremonies of the Indians of this region. That at the north end of the hall by Frank Wilbert Stokes relates to the Eskimo and their country.

The Eskimo collections are being arranged in the adjoining hallway and corridor. Here is a group showing the Eskimo woman cooking in the interior of a snow hut or igloo lined with sealskin. She is using a stone lamp filled with seal oil, which feeds the flame over which the meal is being prepared. Nearby is an Eskimo woman fishing through the ice. She has formed a windbreak with blocks of ice. The fish rod and hook, and the long ladle are made of bone, and with this latter she keeps the water in the hole from freezing over while she is fishing. In this section will be found collections obtained by the Stefansson-Anderson expedition from the Eskimo of Coronation Gulf, some of whom had never seen a white man. In other cases are shown the clothing of the Eskimo, the many ingeniously made implements, and many finely carved and engraved ivory objects.

Auditorium

The doorway at the north end of the hall leads to the *Auditorium*, which has a seating capacity of 1,400, and is equipped with two screens, 25 feet square, for stereopticons. Free public lectures are given here Tuesday and Saturday evenings from October to May under the auspices of the Board of Education. There are also special lectures for Members of the Museum as well as lectures for school children. At the entrance of the lecture hall is appropriately placed a bust of Professor Albert S. Bickmore, originator of the movement that resulted in the erection of the Museum, first curator, and founder of its lecture system.

Power Room

At the end of the corridor is the power room, where may be seen demonstrated the transformation of the potential energy of coal into heat, light and motion.

West Corridor

To the right or west of the Jesup statue are three halls devoted to Indian collections. To reach these the visitor passes through the *West Corridor*, which is devoted to the temporary display of recent acquisitions or small collections of particular interest. Opening from this is the West Assembly Hall, frequently used for temporary exhibitions as well as meetings.

On the landing, at the head of the stairway, is the William Demuth collection of pipes and fire-making appliances from many parts of the world.

AN IROQUOIS WARRIOR

From the Group in the Woodland Indian Hall

SOUTHWEST WING

INDIANS OF THE WOODLANDS

Indians of the Woodlands

The halls to the west contain collections from the North American Indians and together with the hall in the south central wing present the nine great culture areas of North America. (See map on the right of the entrance.)

The hall you now enter represents three of these culture areas. Filling the greater part of the hall are the tribes of the Eastern Woodlands who occupied the middle portion of the North American continent east of the Mississippi. In two wall cases on the left are exhibits of the Mackenzie region of the North and of the related tribes in Alaska west of that region. Midway of the hall on the right side are represented the peoples of the Southeast.

Decorated birchbark vessel of the Penobscot Indians.

Near the entrance of the hall will be found the remains of our local Indians. On the left are some specimens of pottery vessels and many small objects of stone and bone recovered from the Island of Manhattan and the neighboring territory of Staten Island, Long Island, and Westchester. Nearby on the same side of the hall are collections obtained from living Indians of the coast region north and south of New York. These are the Penobscot and Passamaquoddy of Maine, the Micmac and Malecite of the lower provinces of Canada, and a few but rare objects from the Delaware who once occupied the vicinity of New York City and the State of New Jersey.

On the opposite side, the north, are the Iroquois whose league comprised the Mohawk, Seneca, Oneida, Onondaga, Cayuga and later the Tuscarora. They dominated New York and much adjoining territory. The exhibits represent particularly the agriculture of the East, which was carried on with rude tools by the women.

In a case in the aisle are exhibited wampum belts which were highly esteemed in this region. They served as credentials for messengers and as records of treaties and other important events. Later, wampum beads came to have a definite value as currency, especially in trade between the white men and the Indians.

In the farther end of the hall, on the left, are the collections from the Ojibway, Hiawatha's people, who lived mainly north of the Great Lakes. They had but little agriculture, living chiefly by hunting

and fishing. Beyond the Ojibway are the Cree, who live still farther north. Here is to be seen the rabbit skin clothing of our childhood rhymes.

Opposite the Ojibway are the great Central Algonkian tribes, the Menomini and Sauk and Fox, who lived south and west of the Great Lakes. They gathered wild rice and hunted and fished, practicing also some agriculture. In one of the Menomini cases are some skin bags beautifully worked in porcupine quills. These bags were used in the Midewin, the secret society of the shamans.

The dwellings are of several forms, among which may be mentioned the long rectangular houses of the Iroquois covered with oak-bark; the dome-shaped huts of Long Island and vicinity which were covered with mats and bundles of grass; and the familiar conical wigwam of the Ojibway covered with birchbark. The utensils are of pottery, wood or birchbark. Pottery was not made by all the Eastern tribes and seems to be associated with the practice of agriculture. The designs are incised, never painted. Bowls, trays, and spoons are made of wood and often decorated with animal carvings. The use of birchbark in the construction of light, portable, household vessels is a particular trait of our Eastern Indians.

A DANCER OF THE DOG SOCIETY
Arapaho Indian

In the southeastern portion of the United States agriculture was highly developed. These tribes are represented by the Cherokee and Yuchi who made pottery, and by the Choctaw and Chitimacha who have interesting baskets made of cane. The Seminoles of Florida have maintained an independent existence in the Everglades for nearly a century. Their picturesque costumes are shown.

SOUTHWEST PAVILION

INDIANS OF THE PLAINS

The collections from the Indians of the Plains will be found in the hall adjoining. These Indians comprised the tribes living west of the Mississippi and east of the Rocky Mountains as far south as the valley of the Rio Grande and as far north as the Saskatchewan. (See map on south wall.)

Indians of the Plains

Occupying the greater part of the hall beginning on the left are the buffalo hunting tribes: the Plains-Cree, Dakota, Crow, Blackfoot, Gros Ventre, Arapaho and Cheyenne. These tribes did not practise agriculture but depended almost entirely on the buffalo; buffalo flesh was their chief food, and of buffalo skin they made their garments. In some cases a buffalo paunch was used for cooking, and buffalo horns were made into various implements of industry and war. The spirit of the buffalo was considered a powerful ally and invoked to cure sickness, to ward off evil, and to give aid in the hunt. Whenever the buffalo herds led the way, the more

A DOG FEAST OF THE SIOUX

Given in honor of Mr. Sanford, Pierre Choteau and Catlin. From the Catlin Collection of paintings.

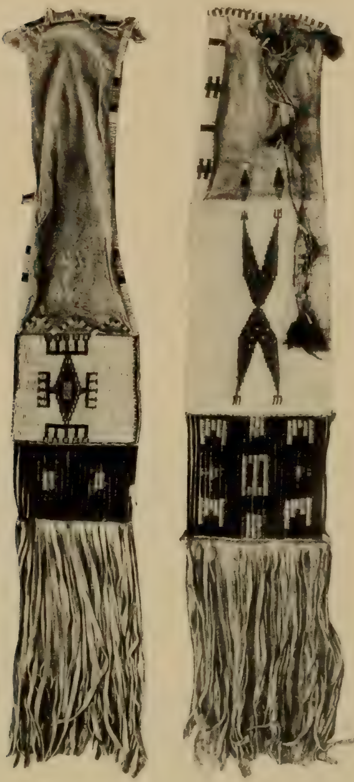
nomadic Plains tribes moved their tents and followed. With the extermination of the buffalo the entire life of the Plains Indians was revolutionized.

On the right, near the entrance, are the village tribes of the Plains: the Mandan with whom Lewis and Clark passed the winter of 1804-1805, the Hidatsa who now live with them, and the Omaha, Kansa, Iowa and Pawnee. All these tribes raised corn and lived in earth covered

houses of considerable size. A small model of one of these houses stands near the exhibits.

Blackfoot Tipi

In the center of this hall is a Blackfoot Indian tipi with paintings of otters on the sides, representing a vision of the owner. This tipi has been fitted up to show the home life of a typical buffalo hunting Indian.



PIPE AND TOBACCO BAGS
Dakota Indians.

Societies

There were numerous soldier societies among the Plains Indians which included practically all the adult males. Each society had a special dance and special costumes. (See the Arapaho cases for costume dances.) There were other dances connected with tribal religious ceremonials, the best known and most important of which is the sun dance, illustrated by a model at the left of the tipi. The sun dance was held annually in the early summer in fulfillment of a vow made during the preceding winter by some member of the tribe who wished a sick relative to recover. The dance involved great physical endurance and excruciating self-torture, lasting three days, during which time the dancers neither ate nor drank.

Sun Dance

Medicine Pipe

In the center of the hall is a genuine medicine pipe, held in awe by the Indians and dearly parted with; also the contents of a medicine pipe bundle. The contents of another medicine bundle, belonging to a leading man of the Blackfoot tribe (medicineman), together with the headdress which he wore in ceremonies, is in a case near the tower.

The Plains Indians are noted for their picture writing on skins and for their quillwork, which has now been superseded by beadwork. They have a highly developed decorative art in which simple geometric designs are the elements of composition, this being one of the most interesting features of their art. (See Dakota case.) [See *Handbook* No. 1. North American Indians of the Plains.]

WEST WING

INDIANS OF THE SOUTHWEST

Pueblo Indians

On the left are collections from the sedentary Indians who occupy the pueblos of the Rio Grande and of Hopi, Acoma and Zuñi; and also the objects recovered from the prehistoric pueblos, caves, and cliff-dwellings. On the right are the nomadic Indians—the Eastern and Western Apache, the Navajo, the Pima and the Papago.

The sedentary Indians live in large community houses, often with several receding stories, built of stone or adobe. They depend chiefly upon agriculture for their food, make a great variety of pottery, and have many elaborate religious ceremonies. The nomadic peoples live in tipis or small brush and thatched houses which are moved or deserted when they are forced to seek the wild game and wild vegetable products which furnish much of their food. They make baskets for household purposes which are more easily transported than vessels of clay. There are models in the hall of the pueblos of Taos and Acoma, of prehistoric cliff-dwellings and of the houses used by the Navajo. In the first alcove on the left is shown the pottery of the villages along the Rio Grande, the principal art of the region, skin clothing, household utensils and ceremonial objects.

The upright cases of the next alcove are filled with wonderful prehistoric pottery. That in the wall case is from Pueblo Bonito. Similar gray and white ware with very elaborate and splendidly executed designs in an adjoining case are from Rio Tularosa, one of the upper tributaries of the Gila, where a vanished agricultural people once lived in pueblos and cliff-dwellings. A third case has material gathered by the Museum expedition now exploring Galisteo Valley, New Mexico. In the table case and in a case standing in the aisle are shown the wonderful art work in turquois, shell, stone and wood of the former inhabitants of Chaco Cayon. These objects, as well as the pottery from Pueblo Bonito mentioned above, were secured by the Hyde expedition.

In the next alcove, devoted to the Hopi, are the costumes, masks, images, and placques used in their ceremonies. Besides the well-known snake dance, the various Hopi villages have many interesting ceremonies, many of which are concerned with the rainfall and their crops.

The inhabitants of Zuñi are believed to be the descendants of the first people seen by the Spanish in 1540. Their former villages, many of which now are in ruins, were probably the "Seven Cities of Cibola," for which Coronado was searching at that time. Although they had

THE APACHE GROUP

The scene is laid in the valley of the San Carlos River, Arizona; the time is summer, and the Indians are shown engaged in the ordinary pursuits of daily life.

missionaries among them for about three centuries, they have retained many of their own religious ceremonies. Many objects pertaining to these ceremonies as well as to everyday life are shown in this alcove. In the last case on this side of the hall are examples of Zuñi and Acoma pottery.

At the north end of the hall opposite the Zuñi, space is given to an exhibit from the tribes of California. In the large end wall case the baskets of the region are arranged so as to show the various types.

Pima

The Pima, east side of the hall, practised irrigation, raising by its aid the corn and beans on which they relied for food and the cotton which they used for their scanty garments. The Papago, with whom they are closely associated, occupied the more arid portions of southern Arizona and northern Sonora, securing their living from such desert products as the giant cactus, the century plant, the yucca and the mesquite and small game. Examples of their food, basketry, pottery, and ceremonial articles are shown.

From the aisle near the Pima-Papago section one catches a glimpse of the home of the Hopi. This large group represents the First Mesa with the village of Walpi. The canvas was painted by Howard McCormick and the figures were modeled by Mahonri Young.

Navajo

The Navajo, a large and widely scattered tribe, inhabit much of the country drained by the San Juan and Little Colorado rivers. During the winter they occupy houses like substantial log houses, but in milder weather camp with the slight shelter of a cliff or a windbreak and shade made of brush. They live by raising corn in the moist valley and on the flesh of their numerous flocks of sheep.

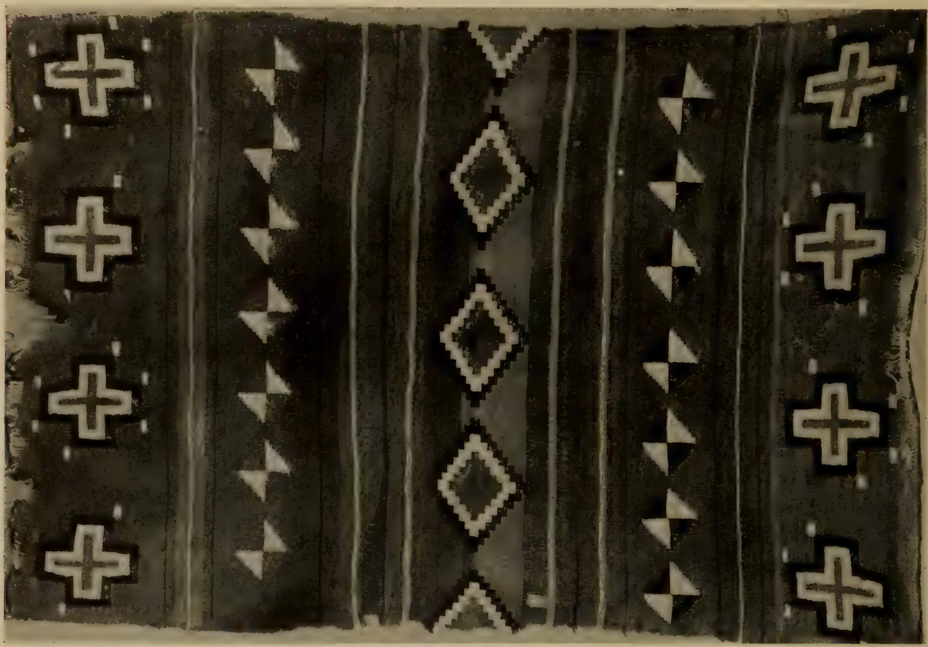
They are the present-day blanket makers of North America. They make use of the wool of the sheep they raise, carding, spinning, and weaving it by means of the simplest implements and looms. This art is believed to have arisen since the coming of the Spanish and it is known to have passed through several stages in the last sixty years. The older types of blankets here shown contain yarn which was obtained by cutting or ravelling from imported flannels, called in Spanish "bayeta," from which the blankets of this sort receive their name. These are either bright red or old rose in color, resulting from cochineal dye. Several blankets are made of yarn bought ready dyed from the traders and are called Germantowns. The greater number, however, contain yarn of native spinning, dyed with native vegetable and mineral dyes.

The Navajo are also expert silversmiths. Their tools and samples of workmanship are displayed in a case in the center of the hall.

The Western Apache live along the upper portion of the Gila and

Apache

Salt rivers, where they practise agriculture, gather the wild products and hunt. These were the people who, under Geronimo, raided the settlements of southern Arizona and northern Mexico and evaded our troops for years. They live in grass-thatched houses or in the open under the shade of flat-topped, opensided shelters. In an adjoining alcove is an industrial group with painted background showing the well-watered San Carlos valley occupied by the Apache for many generations. *It is shown on page 22.*



An attractive Navajo blanket from the Museum's valuable collection The Navajo Indians of the Southwest are a wealthy, pastoral people. and the best Indian blanket makers of North America.

The Eastern Apache lived in Buffalo-skin tipis. They went far out on the plains in search of the buffalo herds, avoiding, if possible, the plains tribes, but fighting them with vigor when necessary. In dress and outward life they resemble the Plains Indians, but in their myths and ceremonies they are like their southwestern relatives and neighbors. The baskets of the Apache are shown in the large end case, which is in contrast with the corresponding case of pottery on the other side of the hall. Not the environment but social habits caused one people to develop pottery and the other to make the easily transported and not easily breakable baskets. [See *Handbook,* Indians of the Southwest.] [*Return to the Jesup Statue.*]

East Corridor

POLAR MAPS

Leaving the statue on the left and "Willamette" meteorite on the right, and going east, the visitor enters the corridor where the elevators are located (*East Corridor*). Here will be found maps of the north and south polar regions showing the routes of explorers. On the wall are sledges used by Admiral Peary in his last three expeditions in search of the North Pole. The Morris K. Jesup sledge, which the Admiral used in his successful polar expedition, is the one nearest the entrance. The various sledges in their differences of style show the persistent effort made by Admiral Peary to bring the sledge up to its greatest possible usefulness. That he was successful on his last trip was in part due to the final modification.

Polar Expeditions

Peary Sledges

On the opposite side of the map is one of the sledges used by Amundsen on his journey to the South Pole. [A history of south polar expeditions is given in *Guide Leaflet* No. 31.]

Amundsen Sledge

In a room at the north end of this corridor is the large Mainka seismograph for recording the occurrence of earthquakes. This was given to the New York Academy of Sciences by Emerson McMillin, and by the Academy deposited in the Museum.

Southwest Wing

JESUP COLLECTION OF NORTH AMERICAN WOODS

To the east of the elevators is the *Hall of North American Forestry* containing the Jesup Collection of North American Woods, a nearly complete collection of the native trees north of Mexico, presented to the Museum by Morris K. Jesup. On the right is a bronze tablet, by J. E. Fraser, the gift of J. J. Clancy, depicting Mr. Jesup as he walked in his favorite wood at Lenox, Mass., and, still farther to the right is the bust of Charles Sprague Sargent under whose direction the collection was brought together.

Jesup Collection of North American Woods

To the left is a section of one of the Big Trees of California, sixteen feet in diameter and 1341 years old. [See *Guide Leaflet* No. 42.] It began its growth in the year 550, so that it was nearly a thousand years

WILD PLUM IN THE FORESTRY HALL

Each of the five hundred species of trees in North America is represented by a section of trunk five feet long, some of a diameter not found in the country's forests to-day. Many of the specimens are accompanied by wax models of leaves, flowers and fruits accurately reproduced from life.

old before America was even discovered. The specimens show cross, longitude and oblique sections of the wood finished and unfinished, and the labels on the specimens give the distribution of the species, the characteristics of the wood and its economic uses. The trees are grouped by families and the location of each family will be found on the floor plan at the entrance of the hall. The reproductions of the flowers, leaves and fruits in natural size are instructive. This work is done in the Museum laboratories.

SOUTHEAST PAVILION

INVERTEBRATES

At the extreme east is the *Darwin Hall*, devoted chiefly to the invertebrate animals (those which do not possess a backbone) and to groups illustrating biological principles. Facing the entrance is a bronze bust of Darwin by Wm. Couper, presented by the New York Academy of Sciences on the occasion of the Darwin centenary in 1909. Passing around the hall from left to right the progression is from the lowest forms of animal life, the one-celled Protozoa, to the highest and most complex forms of animal life, the Primates, including man. The distinctive characteristics of each group are fully described on the alcove and case labels. Many of the minute forms are represented by skilfully prepared models in glass and wax showing the animal many times enlarged. Thus the visitor may obtain an idea of the form and structure of these animals which in spite of their small size have in so many instances such a vital influence on the life of man.

Synoptic Series

This alcove contains the lowest forms of animal life. All are single-celled individuals. The simplest kinds are abundant in swamps and stagnant water, others are found in myriads in the sea, while the ocean bottom in many localities is covered with them. The exhibits in this alcove are mainly models, some of which represent Protozoa enlarged more than a thousand diameters.

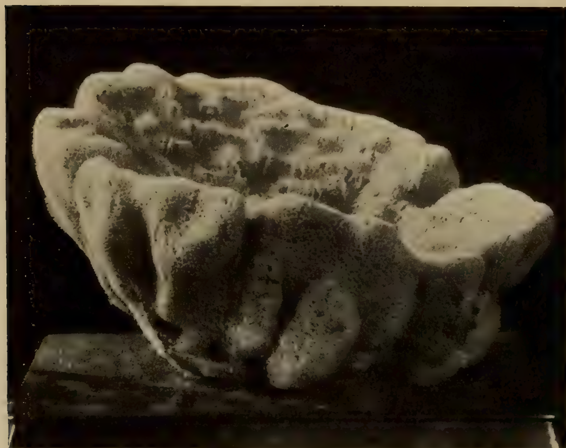
Alcove I Protozoa

Sponges are principally of two kinds—those with skeletons or supporting structures of silica (i. e., flint) and those with skeletons of horny fiber. The sponges of commerce belong to the latter class. In the dry specimens exhibited the skeleton only can be seen, the living tissue having been removed. Many of the "glass" sponges are very beautiful in design. Sponges range in

Alcove 2 Sponges

size from the tiny *Grantia* of the New England coast to the gigantic "Neptune's goblets" found in the eastern seas. This alcove contains certain specimens whose tissue is represented in wax tinted to show the natural coloring of sponges, which varies from the bleached yellowish color commonly seen to deep brown or black, or yellow and red, in varying shades.

Alcove 2
Sponges



European commercial sponge comparable with the Florida yellow sponge or "Hardhead." The sponge industry in both the Mediterranean and the Bahama region is almost destroyed by careless methods, and conservation must be practised here as in other of the world's resources.

Alcove 3
Polyps

In Alcove 3 are shown coral animals and their relatives: plantlike hydroids which often are mistaken for sea moss, but which really are a series of polyps living in a colony; jellyfishes with their umbrella-shaped bodies and long, streaming tentacles; brilliant colored sea anemones, sea fans and sea plumes; the magenta colored organ-pipe coral, the stony corals, and the precious coral of commerce. Coral polyps, mistakenly called "coral insects," are the animals that build up the coral reefs. In front of the window is a life-size model in glass of the beautiful Portuguese Man-of-War. This organism is really a colony of many polyp individals attached to one another, and specialized for various functions.

Alcove 4
Flatworms

The best known species in this group include the tape-worms, whose development and structure are shown by models in the central case and in the third section of the left-hand alcove case. These are parasite flatworms. The less familiar free-living flatworms, which inhabit both salt and fresh water, are shown on an enlarged scale by models in the right-hand alcove case and illustrate well the great diversity of color and detail in this group.

Alcove 5
Roundworms

The Roundworms are also parasitic, since they live in the digestive canal of mammals. The most familiar is the common roundworm or stomach worm, *Ascaris,* of which an enlarged scale model is exhibited, showing the internal structure.

[*Note for teachers and students*—Some of the models in each alcove are *anatomical*, i. e., so constructed as to show the internal organs of typical members of each group. In such cases, arbitrary colors chosen to designate the various systems of organs are adhered to consistently throughout the series. For example, the digestive system is shown in yellow, heart and blood-vessels in red, organs of excretion (kidneys) in green, reproductive system in gray, and the brain and other parts of the nervous system in black or neutral color.]

Alcove 6 Rotifers

The minute wheel animacules comprise many exquisite and grotesque forms, some of which construct tubes of gelatinous substance, sand-grains, etc. A few of the species are parasites, but most of them live a free, active life. They are aquatic and found mainly in fresh water.

Alcove 7 Sea-Mats and Lamp-Shells

The sea-mats in Alcove 7 are plant-like animals which lead the colonial form of life. The majority of the species are marine, although a few occur in fresh water. The lamp-shells shown in this alcove superficially resemble clams, but by structure are more closely related to the worms and starfishes.

Alcove 8 Sea-Stars and Their Relatives

Alcove 8 is occupied by the sea stars, sea urchins, sea-cucumbers and sea lilies. The sea-star is the pest of the oyster beds, where it feeds on oysters and destroys them in large numbers. The brittle stars are so-called because of their habit of dropping off one or more arms when handled or attacked. These, however, are later renewed.

Alcove 9 Annulates

The annulates, typified by the familiar earthworm, are worm whose bodies are made up of rings or segments. They are inhabitants of both fresh and salt water, many kinds living in the mud and sand of the shore while others bore into wood and shells. The marine annulates are often very beautiful in color and greatly diversified in form and habits, as illustrated by the models, many of which are greatly enlarged. The "houses" that these annulates build are often very beautiful and interesting. In the window is a group showing a section of mud flat on the New England coast, with the variety of worm-life found in what to the casual observer seems to be an uninhabited area, and illustrating some of their habits.

Alcove 10 Arthropods

Arthropods include the familiar crabs, lobsters, insects and their relatives. The number of existing species in this group is greater than that of all the rest of the animal and vegetable kingdoms together. No other group comprises so many species useful or harmful to man. In the case

in the center of the alcove is a model showing the anatomy of the common lobster, also enlarged models showing heads of various species of insects. On the wall are the two largest specimens of lobster that have ever been taken. They weighed when alive thirty-one and thirty-four pounds

Crustaceans and Insects

Marine Habitat Group. A community of starfishes, sea anemones, sea urchins and sponges as seen below the edge of a coral reef in the Bahamas.

respectively. The largest of the arthropods is the giant crab of Japan, which, like that placed on the wall, may have a spread of about ten feet. The main exhibit of insects is displayed on the third floor.

Alcove 11 Mollusks

Models of Clam and Oyster

The mollusks form a group second only to the arthropods in the vast number and diversity of forms which it embraces, including marine, fresh-water and land animals. All mollusks have soft bodies, but nearly all of them secrete a shell which in many species is of pearly material (mother-of-pearl). Well-known examples of this group are the common clam and oyster and enlarged models in the center case show the anatomy of these species. A large collection of mollusks is shown on the third floor.

Vertebrates include the largest, most powerful and most intelligent of animals. This group culminates in man, who still bears witness to his chordate ancestry in the retention of a chorda (cartilaginous spine), and gill clefts during embryonic life. Among these ancestral forms are the Ascidians, or Sea-squirts, an enlarged model of which is shown in the central case, while others are seen among the animals on the wharf-piles in the window group. Other models in the central case show the development of the egg of typical vertebrates.

Alcove 12 Chordates Including Vertebrates

In the circular tower alcove in the southeast corner of the hall is a comprehensive synoptic series of stony corals. Central cases in this tower and at its entrance show unusually large specimens, while a magnificent example of madrepore coral six feet in diameter is shown to the rear of the bust of Darwin. The associations of marine life found in the Bahamas are represented by several small groups in the center of the hall.

Corals

Here also four large models show the mosquito, which is the active agent in the spread of malaria. These models represent the insect enlarged seventy-five diameters or in volume four hundred thousand times the natural size. The mosquito in its development undergoes a metamorphosis. The model at the left shows the aquatic larval stage; the larvæ are the "wigglers" of our rain-water barrels. The next model is the pupal stage, also aquatic. The third model is of the adult male mosquito, which is harmless, since it never bites man. The fourth model shows the adult female mosquito in the attitude of biting. It is so arranged as to show the internal organs, thus illustrating a typical insect anatomy. In another case is a series of models showing the life cycle of the malaria germ in the blood of man and in the mosquito.

Models of the Malaria Mosquito

In several of the alcove windows are habitat groups of invertebrates illustrating the natural history of the commoner and more typical animals.

Window Groups

In the Annulate Alcove is shown the Marine Worm Group, reproducing these animals with their associates in their natural surroundings, as seen in the harbor of Woods Hole, Mass. The harbor and the distant view of Woods Hole village with the U. S. Fish Commission buildings are shown in the background, represented by a colored photographic transparency. In the foreground the shallow water of the harbor near the shore is represented in section to expose the animal life found on muddy bottoms among the eel-grass, as well as the chimneys of various worm-burrows. In the lower part of the group a section of the sea bottom

Marine Worm Group

A PART OF THE WHARF PILE GROUP

exposes the worms within the burrows. Several species of these are represented.

Shore Mollusk Group

In the Mollusk Alcove window is shown the natural history of a sand-spit at Cold Spring Harbor, Long Island, including some of the shore mollusks and their associates. The entrance of the harbor is seen in the distance. In the foreground at the edge of the sand-spit a mussel-bed is exposed by the receding tide over which fiddler-crabs are swarming into their burrows. Beneath the water surface an oyster is being attacked by a star-fish, while crabs and mollusks of various species are pursuing their usual activities.

Wharf Pile Group

The window group in the Vertebrate Alcove shows the piles of an old wharf at Vineyard Haven, Mass. Below the low-tide mark the submerged piles are covered with flower-like colonies of invertebrate animals. Among these are sea-anemones, tube-building worms, hydroids, mussels, seamats and several kinds of ascidians or sea-squirts. The latter are primitive members of the Chordate group which includes the vertebrates. Like the embryo of man, they possess during their larval period a chorda or cartilaginous spine. At first they are free swimming but later in life many of their organs degenerate and they become fitted to a stationary mode of life.

Rock Tide Pool Group

In the northeast corner of the Hall, a window group shows the animals and plants of a rock tide-pool, the "Agassiz Cave," at Nahant, Mass. Under a natural bridge below a 60-foot cliff the falling tide leaves a pool in a rocky basin, sheltered within which is a community of sea-anemones, sea-stars, corals, sponges, hydroids and other animals living in the midst of a gorgeous sea-garden of marine plants such as are common on the northern New England coast. Through the arch of the natural bridge may be seen a curious rock formation known as the "Pulpit Rock."

Variation Under Domestication

Other exhibits illustrate certain facts made clear by Darwin, and those who came after him. On the left facing the entrance variation under domestication is illustrated by dogs, pigeons, and domesticated fowls, the wild species from which they have been derived being shown in company with some of the more striking breeds derived from them.

Variation in Nature

On the right, various exhibits will show variation in nature. An example of this is the variation among the finches of the genus *Geospiza* in the Galapagos Islands.

Other examples show by means of a series of mollusks the range of color variation within a single species of West Indian Sun Shell, variation of sculpture within a single genus of land snail, and variations about the normal type of the common scallop.

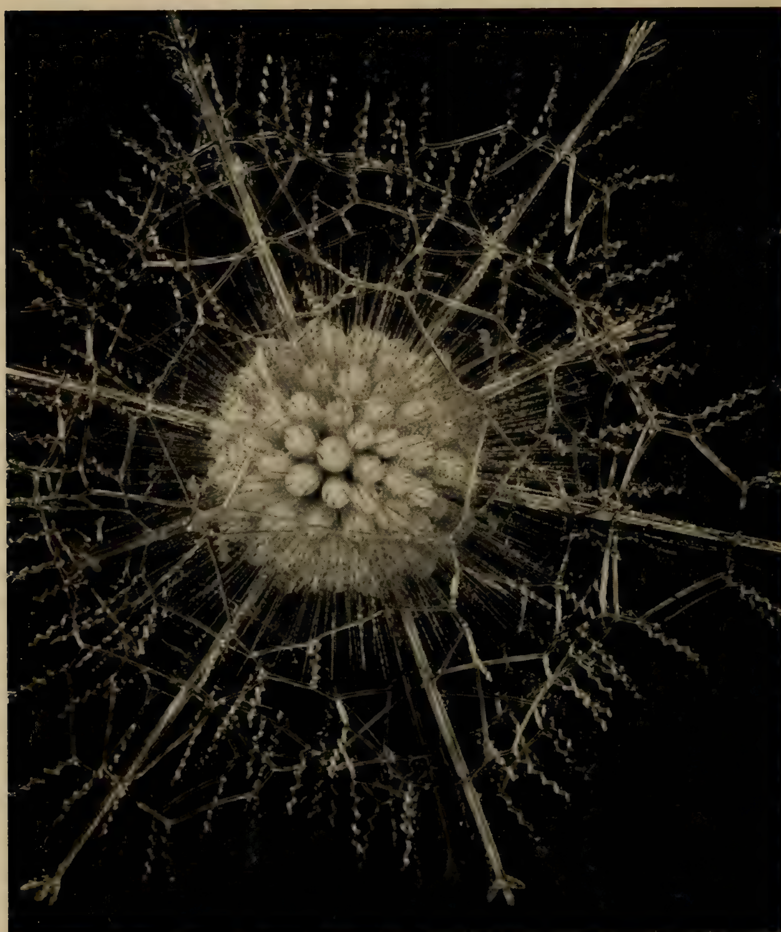
Struggle for Existence

The struggle for existence is portrayed by the meadow mouse, surrounded by its many enemies and yet continuing to mainta'n an existence by virtue of its great birth rate.

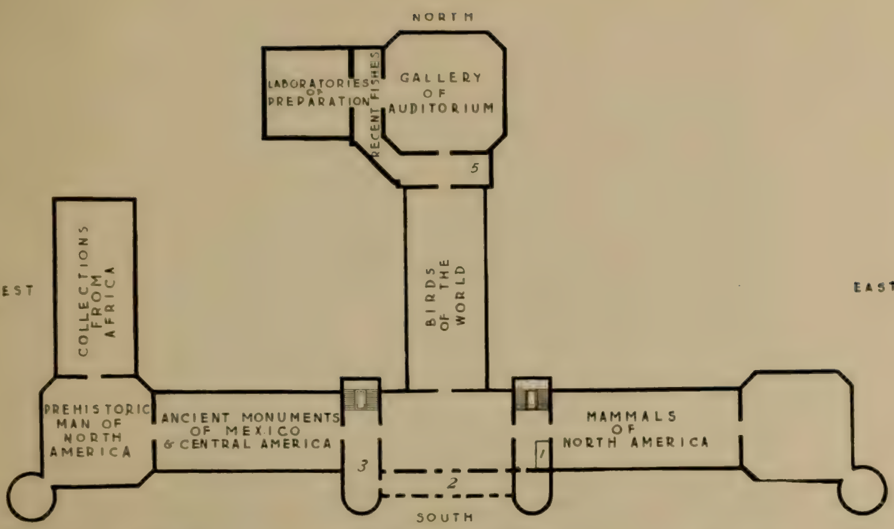
Heredity

The simpler features of the laws of Heredity as elucidated by Mendel and his followers are illustrated by the inheritance of seed-coat color in the common pea, the color of sweet peas, and the coat-color of rats.

[*Return to the elevators and ascend to the second floor.*]



ENLARGED MODEL OF A RADIOLARIAN



1. Elevators. 2. Copies of Maya Monuments. 3. Local Birds.

SECOND FLOOR

SOUTH PAVILION

This hall illustrates a phase of Museum progress, the temporary disorder that precedes an ultimate change for the better. At present the hall contains a mixed assemblage of animals brought hither from other halls in process of rearrangement; later it is hoped that it will contain a series of groups of birds from various parts of the world.

The group of king penguins from South Georgia Island is one of four devoted to the bird life of South America, but is at present provisionally installed, awaiting important changes in hall and cases.

Elephant "Tip"

The Asiatic elephant is the famous "Tip" brought to this country in 1881, and for seven years one of the attractions of Forepaugh's circus. He was given to the City of New York by Mr. Forepaugh and lived in the Central Park Menagerie until 1894 when, because of his treacherous disposition, it was found necessary to kill him. He is said to have caused the death of several of his keepers, and was twenty-three years old when killed.

Reptiles and Amphibians

Here, awaiting the construction of a new wing, is exhibited the collection of reptiles and amphibians. Because of the difficulty of preserving the natural covering of many of these animals they are usually exhibited in jars of alcohol. In the specimens on exhibition here the perishable parts have been cast in wax from

KING PENGUINS FROM SOUTH GEORGIA

The King Penguin is the largest—with one exception—of all Penguins, and it is the most brightly colored. It breeds on various sub-Antarctic islands. The single egg is guarded by each parent in turn; to incubate, the bird places the egg on its feet, where it is further protected with a roll of loose skin. The background, painted by Albert Operti, shows Lucas Glacier on South Georgia, in the South Atlantic Ocean, where material for this group was collected by Robert Cushman Murphy.

life; for example, in the star tortoise the original "shells" of the specimens are used, while the head, neck and legs are restored in wax. The mounting not only brings out the principal features of the species exhibited, but in many instances illustrates also some distinctive habit of the animals; for instance, the common newt, one of the salamanders, is represented by a series of five life-size casts showing the process of shedding the skin; Pickering's hyla or the "spring peeper" is shown with vocal sacs inflated; and so on.

The classification of these animals is shown in the upright cases; the groups in the center of the hall represent various reptiles as they appear in their natural haunts. They include the tuberculated iguana, the water moccasin, the diamond-backed rattlesnake, the Texas rattlesnake, the copperhead, the Gila monster, the pine snake, the box tortoise and the common painted turtle.

Cobra Group

One of the most interesting of the groups is a jungle scene in India showing a water monitor, one of the largest of living lizards, the poisonous Russell's viper and the deadly spectacled cobra, the last with hood distended and poised ready to strike. The cobra is said to be the cause of a large proportion of the 20,000 deaths which annually occur in India from snakebite. Examine carefully the group of the copperhead snake or "red-eye," one of the two species of poisonous snakes to be found in the vicinity of New York, and also the group contrasting the harmless watersnake with the poisonous water moccasin of southern cypresss wamps. Two groups are devoted to rattlesnakes, which are easily recognized by the string of rattles at the end of the tail, by means of which they give warning before they strike. There are comparatively few species of poisonous snakes in the United States—about sixteen in all—comprising rattlesnakes, the moccasin, copperhead and two kinds of coral snake. All other species are harmless and in spite of the almost universal prejudice against them are very useful allies of man, since they live chiefly on rats, mice and insects injurious to crops.

Copperhead Snake Group

Bullfrog Group

Entering the darkened room nearby we find a group of unusual interest, showing the common bullfrog of North America. This group is a study of the bullfrog undisturbed in its typical haunt. It illustrates the changes from the tadpole to the adult frog and shows many of the activities of the frog—its molting, swimming, breathing under water and in air, croaking, and "lying low" before an enemy; also its food habits in relation to small mammals, to birds, snakes, insects, snails, to small fish and turtles.

Another group is the Great Salamander or Hellbender, best known in the creeks of western Pennsylvania. The group pictures them at

LOWER CALIFORNIA LIZARD GROUP

Showing the characteristic animal and plant life of one of the small desert islands off the coast of Lower California. The material for this group was collected by the "Albatross Expedition" of 1911, under Dr. C. H. Townsend.

breeding time, and shows their characteristic stages and habits: thus one of the salamanders is pictured molting, another, a male, is brooding a great mass of eggs; and the group explains many details of their manner of living.

Great Salamander

This depicts the spring life of a little pond in southern New England.

Toad Group

In the water may be seen the egg masses and tadpoles of various toads and frogs, while in and about the pool are the young and full grown in characteristic poses, including some with vocal sacs distended in the act of "singing."

A BIT OF THE TOAD GROUP

Lower California Lizards

In striking contrast with these water loving animals is a group showing one of the desert islands off the coast of Lower California where reptiles must go without water for long periods. *Page 38.*

Florida Group

Latest, largest, and finest of the groups is that showing the semi-tropical life of Southern Florida, on one side a stretch of cypress swamp, on the other the sandy lowlands, each with its characteristic life, alligators, turtles, and snakes.

THE AMERICAN ROBIN—ONE OF THE GROUPS OF LOCAL BIRDS

WEST CORRIDOR

LOCAL BIRDS

Adjoining the *South Pavilion* is the *West Corridor*, which contains the collections of local birds.

In this room are specimens of all the species of birds which have been known to occur within fifty miles of New York City. As far as possible each species is shown in all its different plumages. In the wall-case next the windows on the visitor's left is the *Seasonal Collection*, containing the birds which may be expected to occur in this region during a part or the whole of the current month; in its left-hand two panels are the *permanent residents*, which are never changed, and in the right-hand two are the *migrants*, which are changed as necessary about the first of each month. In the next case on the left come first a panel of *accidental visitors*—stragglers from other parts of the country and from other countries which have been taken within our limits—then the *General Collection* of all birds found within this area, arranged according to the current American system of classification, beginning with the Grebes and continuing around the hall to end with the Thrushes by the southwest window.

Besides the table case containing the eggs (often with the nest) of species known to nest within fifty miles of the City, there are down the middle of the room a series of groups of local breeding birds with their nests. These, the forerunners of our "Habitat Groups," were the first of their kind made for the Museum.

At the head of the stairs, on one side is a map of the country within fifty miles; on the other, exhibits which explain what is meant by a subspecies, and through what changes of plumage a bird passes from the time of hatching.

At the other end of the room, between the windows, is a bust of John Burroughs, by C. S. Pietro.

Southwest Wing

ANTIQUITIES OF MEXICO AND CENTRAL AMERICA

Maya Art

Continuing west past the collection of local birds we enter the southwest wing, devoted to the ancient civilizations of Mexico and Central America. As the hall is approached casts of large upright stones appear completely covered by sculpture. These stones, called stelae, are found chiefly near Copan in Honduras and represent the highest art of the Maya civilization.

At the left of the entrance on the south side of the hall is the extensive exhibit from Costa Rica of Mr. Minor Keith. This includes stone sculpture and a great variety of pottery interesting in form and design. To this collection also belongs the gold and jade from Costa Rica arranged in the cases in the center of the hall. *See page 44.*

On the south wall is a copy of the painted sculptures of the Temple of the Jaguars at Chichen Itza. Here are shown warriors in procession who seem to be coming to worship a serpent god. Prayers are represented as coming from their lips. This sculpture, while Maya, shows strong existence of Mexican influence in certain of its details.

In the table cases on this side of the hall are facsimile reproductions of native books or codices, which were painted free hand on strips of deerskin, paper or cloth. Several original documents are also exhibited. The Spaniards, in their zeal to destroy the native religion, burned hundreds of these books, which recorded ceremonial rites and historical events by means of pictures and hieroglyphs.

Nearby is a replica of the Calendar Stone, which is a graphic representation of the four creations and destructions of the world, as well as a symbol of the sun and a record of the divisions of the year.

THE AZTEC GODDESS OF THE EARTH

The famous statue of the Aztec Goddess of the Earth called Coatlicue, "The Serpent-skirted One," is a striking example of barbaric imagination. It was found in Mexico City near the Cathedral in the year 1791. It doubtless occupied an important place in the great ceremonial center of Tenochtitlan, the Aztec capital, and probably dates from the last quarter of the 15th century.

The head, which is the same on front and back, is formed by two repulsive serpent heads meeting face to face. The feet are furnished with claws, but the arms, which are doubled up with the elbows close to the sides, end each in a serpent's head. The skirt is a writhing mass of braided rattlesnakes. The creature wears about the neck and hanging down over the breast a necklace of human hands and hearts with a death's head pendant in the center. Coatlicue seems to have been regarded as a very old woman and as the mother of the Aztec gods.

In the aisle near the end of the hall stands a copy of the great sacrificial stone, or Stone of Tizoc, on which is a record of the principal conquests made before 1487.

The statue of Coatlicue, the mother of the two principal Aztec gods, is a curious figure, made up of serpents. *See page 42.*

These three sculptures were originally in the Great Temple enclosure at Tenochtitlan, the native name of Mexico City before its conquest by Cortez, but they have been removed to the Mexican National Museum.

The Nahua culture of Mexico extended through many centuries, relics of which are found deposited in distinct layers, one above the other. In the valley of Mexico there are three so-called culture horizons, the last being that of the Aztecs. These three stages of culture are represented on the north side of the hall beginning at the western end. We first have the Archaic Period as represented in the culture of Tarasca and Jalisco. Here are many crude figurines of pottery. The eyes and other features are formed by adding fillets of clay which are afterwards rudely modeled.

Next in order is the culture of the Toltecs, who were skilled in making pottery, the decorations of which were frequently stamped on with terra cotta stamps. Examples of this work together with the stamps are shown in one of the cases.

Near the middle of the hall the final period, that of the Aztecs, is shown representing their work in clay and stone.

Near the east end of the same side of the hall in the same order will be found the Archaic Period of Central America, and the succeeding Maya civilization as represented at Chichen Itza and Copan.

The Maya were perhaps the most highly civilized people in the New World. They built many cities of stone and erected many fine pillar-like stelae to which attention was called on entering the hall. The sculptures on these monuments represent priest-like beings who carry serpents and other ceremonial objects in their hands. There are also on them long hieroglyphic inscriptions containing dates in the wonderful Maya calendar. Maya history contains two brilliant periods. That of the south, extending from 160 A. D. to 600 A. D., was chiefly remarkable for its sculptures. The principal cities were Copan, Quirigua, Tikal, Yaxchilan and Palenque. The second period fell between 950 A. D. and 1250 A. D., and centered in northern Yucatan. The chief cities were Chichen Itza, Uxmal and Labna, and the finest works of art were architectural. (See *Handbook*, No. 3, Ancient Civilizations of Mexico and Central America.)

ANCIENT GOLD OBJECTS FROM COSTA RICA
In the Minor C. Keith Collection

SOUTHWEST PAVILION

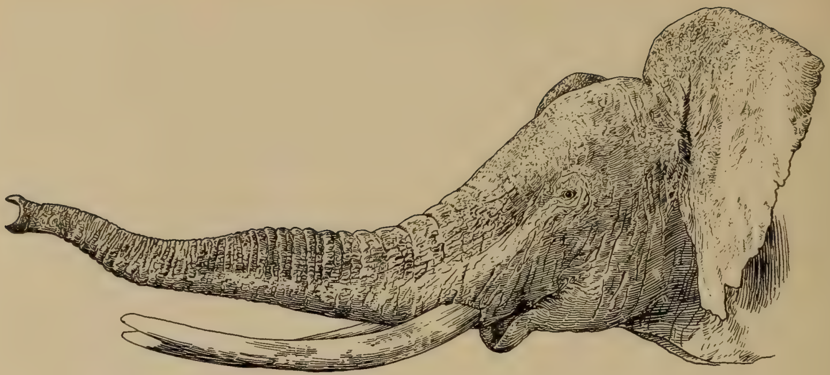
PREHISTORIC MAN OF NORTH AMERICA

Continuing west we pass into the *Southwest Pavilion*, likewise given over to archæology, in this instance that of North America. Here are examples of ancient pottery, arrow-heads, stone axes and other implements of stone and bone, mostly from burial mounds. The most important of these are the rude implements and fragments of human bones from the Trenton gravels, as these are the most probable evidences of man's antiquity on this continent. Notice that the arrangement of the hall is geographical and by states. In addition there is a special exhibit of Mississippi Valley pottery in the wall cases and the Douglass type specimen series in the cases to the left.

Prehistoric Man in Europe

In the adjoining tower room are the implements and carvings made by the early inhabitants of western Europe. These are arranged in an evolutionary series, beginning with the so-called eoliths in the first case on the left, and continuing through the various stages of the paleolithic period to the neoliths of more modern times. This series, showing the gradually improving skill and artistic taste of primitive man, represents at least two hundred and fifty thousand years of man's early history, during which time Europe passed through alternating warm and frigid conditions as the great glacial ice cap crept down from the north and receded. This changing climate was accompanied by corresponding changes in the animals associated with man and on which he largely lived. Some of these are represented by the paintings on the walls copied from the caves of northern Spain and southern France where, soon after the final retreat of the great glacier, man left us illustrations in color of the bison, mammoth, reindeer and horse of that day.

On either side of the tower entrance are cases devoted to physical anthropology. The case on the left illustrates the various types of skulls of living man with the measurements on which they are classified. On the right is a comparative historical series showing the gradual devolopment of the human race.



West Wing

COLLECTIONS FROM AFRICA

Opening to the north from this hall of North American Archæology is the *African Hall.* This differs from other halls in containing besides ethnographical specimens a number of characteristic African mammals. The future extension of the Museum will provide room for groups of African mammals, including elephants. The installation is geographical, i. e., as the visitor proceeds through the hall from south to north he meets the tribes that would be found in passing from south to north of Africa, and the west coast is represented along the west wall, the east coast along the west wall.

There are three aboriginal races in Africa: the Bushmen, the Hottentot, and the Negroes. In the north the Negroes have been greatly influenced by Hamitic and Semitic immigrants and become mixed with them.

At the south end of the Hall the wall is decorated with reproductions of cave-paintings made by the Bushmen, the most ancient and primitive of African natives. These works of art are remarkable for their realism, and should be compared with the reproductions of old European cave-paintings in the tower of the adjoining hall.

Nothing is more characteristic of the Negro culture, to which the rest of the Hall is devoted, than the art of smelting iron and fashioning iron tools. The process used by the African blacksmith is illustrated in a group near the entrance, on the west side, and the finished products, such as knives, axes, and spears, are amply shown throughout the Hall. The knowledge of the iron technique distinguishes the Negro culturally from the American Indian, the Oceanian and the Australian.

All the Negroes cultivate the soil, the women doing the actual tilling while the men are hunters and, among pastoral tribes, herders. Cloth-

ing is either of skin, bark cloth, or loom-woven plant fiber. The manufacture of a skin cloak is illustrated by one of the figures in the group to the left of the entrance; bark cloths from Uganda are shown in the northeastern section of the Hall; while looms and the completed garments are shown in the large central rectangle devoted to Congo ethnology. The most beautiful of the last-mentioned products are the "pile cloths" of the Bakuba, woven by the men and supplied with decorative pattern by the women. Very fine wooden goblets and other carvings bear witness to the high artistic sense of the African natives, who also excel other primitive races in their love of music, which is shown by the variety of their musical instruments.

A unique art is illustrated in the Benin case in the northern section of the Hall, where the visitor will see bronze and brass castings made by a process similar to that used in Europe in the Renaissance period. It is doubtful to what extent the art may be considered native.

The religious beliefs of the natives are illustrated by numerous fetiches and charms, believed to give security in battle or to avert evils. Ceremonial masks are shown, which were worn by the native medicine-men.

[*Return to Central Pavilion.*]

South Central Wing

BIRDS OF THE WORLD

Birds of the World

Going north we enter the hall containing the general collection of birds. In the first four main cases on the right the 13,000 known species are represented by typical examples of the principal groups arranged according to what is believed to be their natural relationship. The series begins with the Ostriches, the "lowest" birds (that is, those which seem to have changed least from their reptilian ancestors), and goes up to those which show the highest type of development, the Singing Perching Birds such as our Thrushes and Finches. The remaining cases on the right wall and all of those on the left show the geographical distribution of the bird fauna of the world. The specimens are grouped according to the great faunal regions, the Antarctic, South American Temperate, American Tropical, North American Temperate, Arctic, Eurasian, Indo-Malay, African and Australian realms. These cases in connection with the accompanying maps give opportunity for a comparative study of the birds of the different parts of the world. In each region, as in the Synoptic Collection, the birds are arranged in their natural groups to the best of our present knowledge.

THE DODO

Restored from Old Dutch Paintings. This gigantic, monstrous pigeon was abundant in Mauritius when the island was discovered, but was quickly exterminated by the early Dutch navigators.

Extinct Birds

Down the middle of the hall near the entrance are several cases containing birds which have become extinct or nearly so. The Labrador Duck, once a common visitor to our Long Island shores, became extinct for no known reason. The great Auk and the Dodo were flightless species which bred in great numbers on small islands and were easily and quickly killed off by men. The Passenger Pigeon of North America lived by the million in such dense

THE PTARMIGAN IN WINTER

One of a series of four small groups showing this bird's seasoned changes of color as brought about by molting and feather growth.

flocks that vast numbers were slaughtered with ease, but the last individual died in captivity Sept. 1, 1914. The Heath Hen formerly had a wide range on our Atlantic seaboard, but as a game bird it was so continually persecuted, in and out of the breeding season, that it is now extinct except for a colony under protection on the island of Martha's Vineyard. Specimens of all of these birds are shown here, the Dodo being represented by an incomplete skeleton and by a life-size reproduction copied from an old Dutch painting. Others of our splendid game birds, such as the Trumpeter Swan and Eskimo Curlew, are nearly, if not quite, gone and more, like the Wood Duck and Wild Turkey, will soon follow them if a reasonable close season and limited bag be not rigidly enforced. Still others—the beautiful Egrets and the Grebes, for example—have already gone far on the same road owing to the great demand for their plumage for millinery purposes.

Also down the center of the hall, and in certain alcoves as well, are several cases designed to illustrate the general natural history of birds.

LABRADOR DUCKS, NOW EXTINCT
From the Group in the American Museum.

General Topics The widely different plumages (varying with age, sex, season, or all three) often worn by one species will be found illustrated in the Ptarmigan case and in the case containing Orchard Orioles, Snow Buntings, Scarlet Tanagers and Bobolinks. The relationship between structure and habits, the many forms of bill, feet, wings, tail, etc., and the different ways of using them are illustrated in other cases, particularly by one showing the feeding habits of some birds. Other cases show instances of albinism, hybridism and other abnormalities; the excessive individual variation in a bird called the Ruff; birds of prey used by man in hunting; a few domestic birds (an extensive collection of which will be found in Darwin Hall); the growth of the embryo and the structure of the adult bird; Archæopteryx, the oldest fossil bird; and a map-exhibit of migration.

Eggs In the alcoves to the right the first egg case contains the Synoptic Collection of Eggs, which shows the variation in the number in a set, size, shell-texture, markings, shape, etc., and tells something of the laws governing these things. The succeeding cases contain the general exhibition collection of nests and eggs, principally those of North American and of European birds.

Birds of Paradise Near the center of the hall is a nearly complete collection of the Birds of Paradise, presented by Mrs. Frank K. Sturgis. This family of birds is comfined to New Guinea, Australia and some neighboring islands. Their feet and bills show their close relationship to the Crows and Jays, which they resemble in nesting habits as well. Their chief characteristic is of course their gorgeous plumes, wonderful as well in variety of form and position as in beauty. For these plumes the birds are still being killed in such large numbers

that unless the demand for them soon ceases all the finer species will be exterminated, as the Great Bird of Paradise is already believed to be. More Birds of Paradise have been sold at a single London auction (23,000 in two sales) than are contained in all the museums of the world.

In this hall, too, are a number of groups of local and other birds which are placed here only temporarily. In fact, much of the arrangement of the hall will be changed as soon as circumstances permit.

Finback Whale Suspended from the ceiling is the skeleton of a Finback Whale, sixty-two feet in length.

THE WHOOPING CRANE
A bird almost extinct. Shown in the "Habitat Groups."

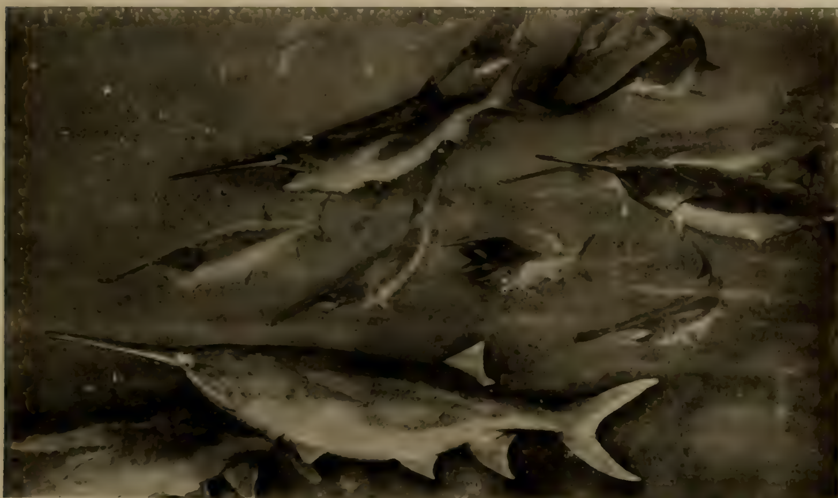
THE BOWFIN GROUP

To illustrate the nesting habits of the bowfin or mudfish (*Amia calva*). At the left the male and female fishes are seen over a nest; at the right a male is standing guard over the eggs. The materials for the group were collected at Fowler Lake, Oconomowoc, Wisconsin, in May, 1912.

RECENT FISHES

The exhibit of fishes occupies the center of the north end of the hall of the birds of the world and the corridor beyond the door leading to the gallery of the *Auditorium*.

The exhibit includes typical examples of the various groups of backboned animals popularly comprised in the term "fishes," and is arranged in progressive order. The visitor should first examine the case of hagfishes and lampreys facing the large window, near the end of the corridor. These rank among the most primitive "fishes." They are with-



A PORTION OF THE PADDLEFISH GROUP

out scales, without true teeth, without paired limbs, and their backbone consists of but a rod of cartilage. One of the models shows the way in which a newly caught hag-fish secretes slime, forming around it a great mass of jelly. In the same case are lampreys, and one of them is represented attached to a fish, which it fatally wounds. The nest-building habit of lampreys is illustrated in a neighboring floor case: here the spawners are preparing a pit-like nest and carrying away stones, which they seize with their sucker-like mouths.

Hag-fishes and Lampreys

The visitor should next inspect the cases of sharks which are situated on the south side of the corridor. These include various forms of sharks and rays, selected as typical members of this ancient group—for the sharks have numerous characters which put them in the ancestral line of all the other groups of fishes.

Sharks

LUMINOUS DEEP-SEA FISHES

At the top as seen in daylight; below as they would appear in the deep sea by their own phosphorescence.

Next to be visited are the silver sharks or *Chimaeroids*, which are exhibited by the side of the lamprey case. They are now known to be highly modified sharks: their scales have failed to develop, and their heavy "teeth" appear to represent many teeth fused together. These fishes are now very rare and, with few exceptions, occur in the deep sea. The present models show the characteristic forms.

Lungfish

The adjacent case pictures the three types of surviving lungfishes, and the models are arranged to indicate the life habits of these interesting forms. Thus they are shown going to the surface of the water to breathe; and their poses indicate that they use their paired fins just as a salamander uses its arms and legs. In fact, there is reason to believe that the land-living vertebrates are descended from forms closely related to lungfishes. One sees in this case also a "cocoon," in which the African lungfish passes the months when the streams are dried up and during which time it breathes only by its lungs.

Window Groups

Returning again to the cases of sharks, one sees on a panel above them two huge sturgeons and two large garpikes. These are examples of the group known as Ganoids—fishes that represent, as it were, a halfway station between lungfishes and sharks on the one hand, and the great tribe of bony fishes on the other—such as perches, basses, cod, etc. A further glimpse of the Ganoids may now be had by viewing the spoonbill sturgeon (paddlefish) group, on the side opposite. In this group a number of these eccentric fishes are shown side by side with garpikes and other characteristic forms from the lower Mississippi. This group was secured through the Dodge Fund. In the window are groups showing the shovel-nosed sturgeon, and the spawning habits of the bowfin and of the slender-nosed garpike,—all Ganoids. *See page 54.*

Passing now through the door leading to the Bird Hall, we are confronted by a case containing additional examples of the Ganoids. Here one sees garpikes, sturgeons, the mudfish (*Amia*), together with the African Bichir, a curious Ganoid encased in bony scales and retaining structures which bring it close to the ancestral sharks.

Teleosts

The remaining cases in the center of the bird hall give characteristic examples of the various groups of modern "bony fishes," or Teleosts. There are fourteen cases of them in all, but they offer little space in which to illustrate the 10,500 species. For these are the fishes which are dominant in the present age, contributing over nine-tenths of all existing forms and including nearly all food and game fishes such as bass, cod, eel and herring.

The cases should be examined in the order in which they are arranged; and one may pass in review the catfishes, carps, eels, trout, salmon,

pike, mullets, mackerel, basses, wrasses, drumfish, sculpins, cods, flatfishes and anglers.

Deep-Sea Fishes

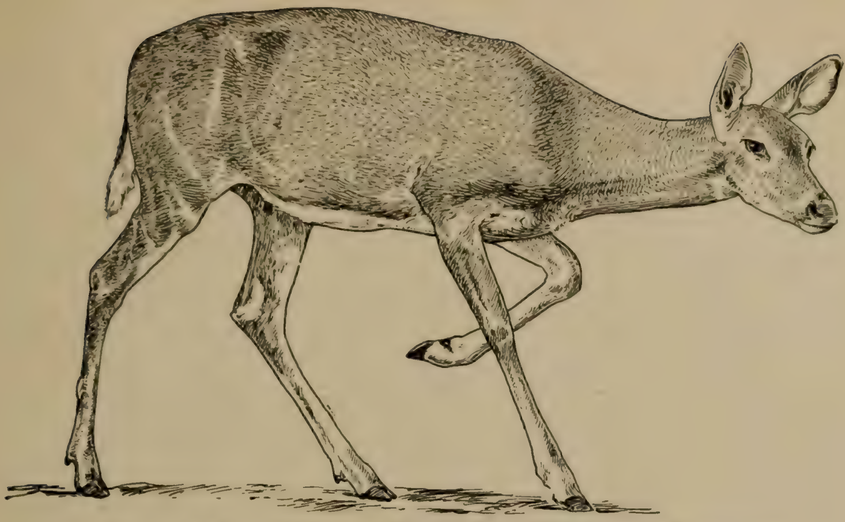
The end case exhibits the grotesque fishes from deep water, in which they occur to the surprising depth of over 3,000 fathoms, or more than 3½ miles. They are usually soft in substance, with huge heads and dwarfish bodies, and are often provided with illuminating organs like little electric bulbs, which can be "shunted" off or on by the fish, and enable the fishes either to see their neighbors or to attract their prey. A group representing a number of these fishes as they are supposed to appear in the gloom of the profound depths, lit up only by their luminous organs, is shown in an enclosure next to the Paddlefish Group mentioned above. *See page 56.*

Before the visitor has completed his view of the hall, he should examine the two wall cases, on either side of the doorway, which explain the characteristic structures of fishes of different groups, and the way in which the groups are related to one another. In one of these wall cases various kinds of fishes have been arranged in a genealogical tree, and the lines and labels give an idea of their evolution.

Above the cases hangs a reproduction of the Giant Ray or "devilfish" over sixteen feet across, taken by Mr. Coles, with whom Colonel Roosevelt made the expedition described in Scribner's for October, 1917.

[*Return to the Elevators.*]

CHIMÆRA, A DEEP SEA "SILVER SHARK"



THE VIRGINIA DEER—A CHARACTERISTIC NORTH AMERICAN MAMMAL

Line drawing from the mounted specimen. This Virginia doe stands as the first example in the Museum of the new methods of animal sculpture as opposed to the old taxidermy. It was mounted and presented by Carl E. Akeley in 1902.

Southeast Wing

MAMMALS OF NORTH AMERICA

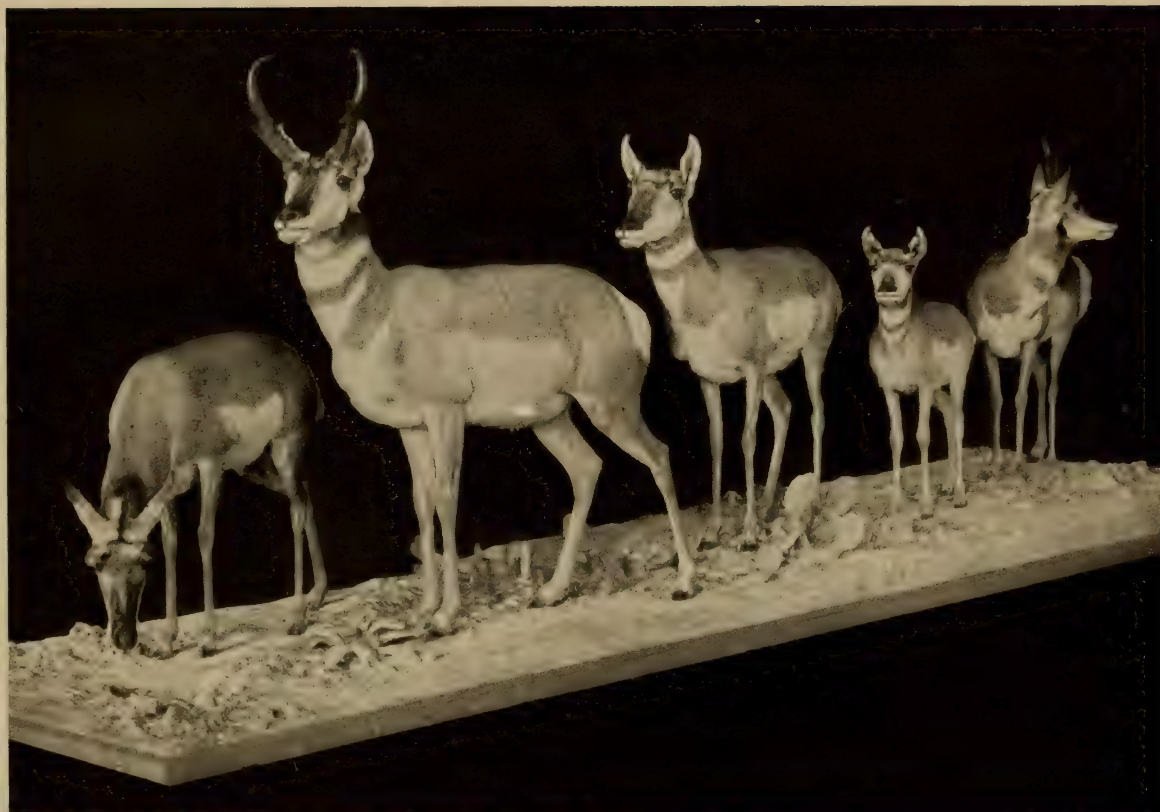
Continuing east beyond the elevator corridor, we enter the hall devoted to North American mammals. Something like 2,000 kinds or species and subspecies of mammals have been described from North America and the purpose of the exhibits is to show those that are peculiar to that region or characteristic of it, the more important, or more striking, being displayed in groups that tell something of their home life or of the region in which they live. The individual specimens give some idea of the variety of species found in North America and their range in size and color.

The appearance and arrangement of the hall is impaired by the *Boreal Mammals* placed here in order to provide room in the adjoining hall for work on the great group of African Elephants and other mammals.

Moose

Bison

The first mammal to catch the eye is the giant moose of Alaska. Back of this is a group of moose from New Brunswick, and beyond this the American bison; these groups, mounted years ago, are still among the finest examples of their kind.



A GROUP OF PRONGHORN ANTELOPE, SHOWING THE MANNER IN WHICH THEY WANDER ACROSS THE PLAINS
This animal is peculiar to North America and is the only hollow-horned ruminant in which the horn sheaths are shed yearly.

On the north, or left side of the hall, is a group of Virginia deer, a familiar and widely distributed species, shown in their summer coat. Farther on are the great brown bears of Alaska, the grizzly bear, a family of fur seals from the Pribilof Islands, and a family of Rocky Mountain goats.

Virginia Deer

THE WEASEL IN WINTER

One of the groups representing the small mammals found within fifty miles of New York City. The others of the series show opossum, raccoon, red and gray foxes, skunk, mink, muskrat, woodchuck, rabbits and squirrels. The list includes some "fur-bearing" species; weasel fur is often used instead of ermine.

In the case immediately at the left of the entrance, and in the alcoves, are groups of small mammals, including many found within fifty miles of New York City.

Opossum

One of these groups shows the opossum, the sole representative in the United States of the marsupial or pouched mammals. With what appear to be the head and ears of a pig and the prehensile tail of a monkey, with a strange pouch for the transportation of the young, and with proverbial cunning and remarkable tenacity of life, the opossum is one of the quaintest

FUR SEALS ON KITOVI ROOKERY, PRIBILOF ISLANDS

and most interesting of North American mammals. This is the animal so famous in the negro songs of the South.

Raccoon
Foxes

Next is the raccoon, more commonly known as the "coon." It is nocturnal in habit and makes its nest in hollow trees. Two species of fox are shown, the red fox and the gray fox, both of which are justly famous for their sly cunning.

BISON COW AND CALF
The big game of North America is described in Guide Leaflet No. 5, North American Ruminants.

Skunk

The common skunk is a very useful although greatly abused animal. While it occasionally destroys poultry and other birds, its principal food consists of injurious insects and field mice. Its defensive weapon is an excessively fetid fluid secreted by a pair of glands situated near the base of the tail. It has the ability to eject this fluid to a considerable distance. Its skin makes a valuable fur known as "Alaskan sable."

Otter
Mink and Weasel

Other fur-bearing animals shown are the mink and otter and the weasel, the latter in both its summer dress of dull brown and its winter coat of white. Weasel fur is often used in place of ermine.

Muskrat

Another important fur-bearing animal shown is the muskrat. In the group are seen its summer home, usually a burrow in the bank of a stream or pond, and its winter mound, constructed of swamp grass and roots mixed with mud. Muskrats are extensively

THE AMERICAN BEAVER

This shows the work and home life of the beaver. The old beavers are cutting trees for food and for building dams and houses. In the foreground a house with part torn away to show the little beavers within.

trapped for their fur, and in 1913 no less than 4,500,000 were sold in London.

Brown Bat

Back of the gray fox a group of little brown bats shows about a hundred of these animals gathering in Wyandotte Cave, Indiana, for their long winter sleep.

Woodchuck

The woodchuck or ground hog is a vegetable feeder, but does very little harm to crops save clover. It hibernates for a large part of the year, usually from September to April. The old legend says that the ground hog comes out of his hole on the second of February, and if it is bright and he sees his shadow he goes back into his hole for six weeks longer and we may expect more cold weather.

Hares and Squirrels

Other groups represent the varying hare, the jack rabbit amid the characteristic sage brush, and the common species of squirrels.

Pack Rats

Pack rats, so called from their habit of packing off, carrying away, small articles, are characteristic of the mountain regions of the West, though one species is found near West Point.

In the center of the hall is a group showing the color phases of our black bear, from which it appears that in a part of its range the black bear is literally a white bear.

Roosevelt Elk and Mountain Sheep

At the end of the hall is a group of Roosevelt elk found in the Coast Range from British Columbia to Northern California. Once abundant, they have become much reduced in numbers, though an effort is now being made to preserve them. On the opposite side of the hall are the mountain sheep or bighorns.

Beaver

Nearby is a group of that interesting animal, the beaver, perhaps the most important of North American mammals and one intimately connected with the early history and exploration of this country.

Antelope Group

On the south side of the hall are displayed some of the cloven-hoofed animals of North America. These include sheep, musk ox, caribou, collared peccary and various species of deer. In one of the cases is a group of antelope showing the manner in which they wander across the plains.

Here too are, for the time being, shown the mammals of the polar regions, placed in the North American hall in order that the *Southeast Pavilion*, which once harbored them, may be used as a workroom for the preparation of a group of African elephants and other mammals from the dark continent.

AFRICAN CHIEF MANZIGA
One of the figures illustrating the principal races of man

Grant's Caribou Group Grant's caribou inhabits the barren ground of the extreme western end of the Alaskan peninsula. The type specimen of this species is in the Museum.

Walrus Group Near by is a group of the Atlantic walrus. These huge mammals are relatives of the seals, inhabit the waters of the Far North and are still fairly abundant along the shores of Greenland. The seal and walrus are the animals which play such an important part in the life of the Eskimo. From these animals come the principal food supply, skins for clothing, for fishing and hunting gear, boat covers, and harnesses for dog teams; from bones and tusks are made knives, bows, harpoons, and other hunting and cooking utensils.

Peary Musk Ox Group The specimens in the musk ox group were collected for the Museum by Admiral Peary in 1896. Musk oxen inhabit the snow-covered wastes of the Arctic barrens, living mainly upon willow leaves, dug up from under the snow.

Note the various devices in the way of labels introduced to make the exhibits interesting and instructive. At the entrance attention is called to the principal causes influencing the distribution of mammals; on many of the labels are maps showing the range of the species shown, and near the group of mountain sheep is a label including a map and miniature models illustrating the species of North American mountain sheep and their range.

Southeast Pavilion

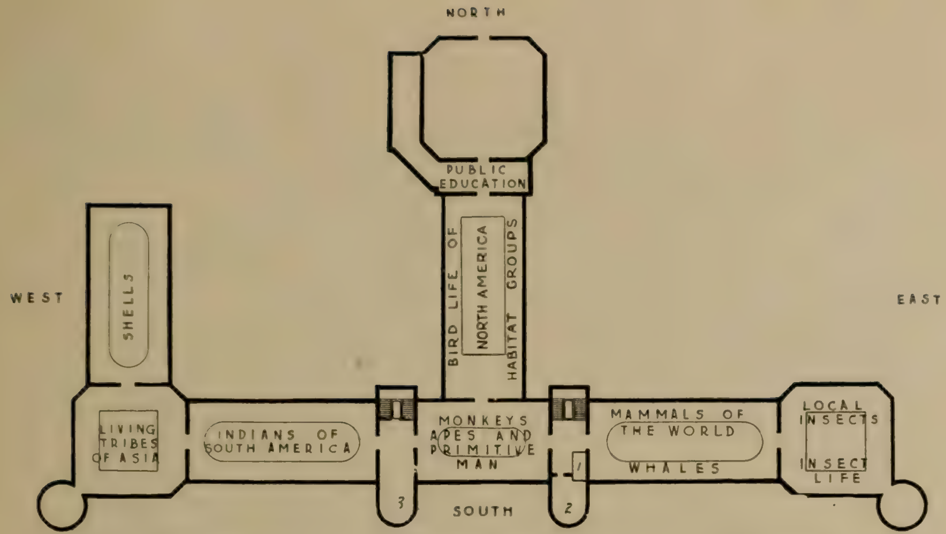
Owing to lack of an appropriation, no additions have been made to the Museum building for the past ten years, and although a new wing was authorized and the excavation for the basement actually made, work was stopped in 1912.

Owing to this fact, and the continued work of the Museum expeditions, all space in the Museum, and especially the storage rooms and work rooms, have become badly congested. When Mr. Akeley began the preparation of the group of African Elephants, intended as the central piece for the projected African Hall, it was necessary to clear out the Southeast Pavilion in order to provide necessary space; when the collections were received from the Congo Expedition, the collection of fishes was removed from the Central Corridor to the Bird Hall to furnish a little storage room. The beautiful Reptile Groups are installed in temporary quarters in the Central Pavilion, Second Floor, while nothing can be done toward exhibiting the collection of Mammals of the Sea, and the African Hall—the most beautiful and comprehensive museum exhibit yet devised—is still in the future.

[*Return to the Elevators and ascend to the Third Floor.*]

AFRICAN RED MONKEYS

One of the new groups in the Primates Hall, showing these rare monkeys in their characteristic poses.



1. Elevators 2. Members' Room 3 Public Health

Third Floor

EAST CORRIDOR

Members' Room To the left of the elevators is a room set apart for the use of honorary or subscribing members of the Museum where they may leave their wraps, rest, write letters, or meet their friends. Nearby is a bronze tablet in memory of Jonathan Thorne, whose bequest provides for lectures and objects for the instruction of the blind.

South Pavilion

APES, MONKEYS, BATS, RODENTS

This hall, in course of rearrangement, is to contain, besides the Primates, which include man, apes, monkeys and lemurs, the small systematic series of insectivores, bats, and rodents.

The Systematic Series of Primates, intended to give some idea of the number of species in this order, and their range in size, form and color, begins on the left with examples of the principal races of mankind and is continued in the wall cases around the room, ending with the lemurs.

Horse-Tailed Monkeys Species of especial interest are shown in groups, the first to meet the eye being the beautiful black and white horse-tailed monkeys.

GROUP OF FRUIT BATS

PROBOSCIS MONKEY
One of many interesting forms in the Primates Hall.

The orang utans, on the south, or left side, show a family of these great apes feeding on durians. This group, one of the first groups of large animals to be mounted in this country, was looked upon as a daring innovation.

Orang Utans

The red monkeys, engaged in rolling up sheets of moss, as one would a rug, to get at the insects beneath, illustrate the point that some monkeys feed largely on the ground.

African Red Monkeys

At the other extreme are the spider monkeys, so named from their slender, spidery limbs, who dwell in the tree tops under the roof of the jungle.

Spider Monkeys

Noteworthy among the single specimens is the gorilla, largest and most powerful of apes; "Mr. Crowley," for many years a resident in the Central Park Zoo, and the curious proboscis monkey from Borneo.

Skeletons of man and the large apes illustrate the similarities and differences in structure between them and there is an important series of skeletons of monkeys and lemurs.

The fruit bats, often known as flying foxes, the largest members of the order and found only in the warmer parts of the Old World, are represented by a small portion of a colony from Calapan, Philippine Islands. Such a colony may number several thousands, and be very destructive to bananas and other fruits.

Fruit Bats

THE ORIZABA GROUP
The observer is looking across the valley of the Rio Blanca, over the tropical forest, to Mount Orizaba.

DUCK HAWK ON PALISADES OF THE HUDSON

Realism and artistic effect have been achieved in the "Habitat Bird Groups," and they present vividly many stories of adaptation to environment.

South Central Wing

BIRD GROUPS

Here are the "Habitat Groups" of North American birds. This unique series of groups shows the habits of some typical American birds in their natural haunts. The groups have been prepared under the immediate direction of Frank M. Chapman, curator of ornithology, who collected most of the specimens and made practically all of the field studies necessary for their reproduction. In the course of this collecting, he traveled more than 60,000 miles. The backgrounds are reproductions of specific localities, painted from sketches made by the artist who usually accompanied the naturalists when the field studies for the groups were made. Practically all sections of the country are represented;

thus the series not only depicts characteristic bird-life of North America, but characteristic American scenery as well. The backgrounds of the groups were painted by Bruce Horsfall, Charles J. Hittell, J. Hobart Nichols, Carl Rungius, W. B. Cox and Louis A. Fuertes. The foliage and flowers were reproduced in the Museum laboratories from material collected in the localities represented. Each group is fully described in the label attached to the case. [See *Guide Leaflet* No. 28.] Beginning with the case at the right of the entrance and passing on to the right around the hall, we find the groups arranged in the following sequence:

Orizaba Group

The distribution of birds, notwithstanding their powers of flight, is limited in great measure by climate. Thus in traveling from Panama north to Greenland there are zones of bird-life corresponding to the zones of temperature. This condition is illustrated on the mountain of Orizaba in Mexico, where in traveling from the tropical jungle at its base to its snow-clad peak the naturalist finds zones of life comparable with those to be found in traveling north on the continent. Thus the Orizaba group so far as the distribution of life is concerned is an epitome of all the groups in the hall.

Cobb's Island Group

Among our most beautiful and graceful shore-birds are the terns and gulls, which (because of their plumage) have been so ceaselessly hunted and slaughtered for millinery purposes that now in their breeding-places there are only hundreds where formerly there were thousands. The group represents a section of an island off the Virginia coast where the birds are now protected by law.

Duck Hawk Group

The duck hawk may be found nesting on the Palisades of the Hudson almost within the limits of New York City. It builds nests on the ledges of the towering cliffs. This hawk is a near relative of the falcon which was so much used for hunting in the Middle Ages. It often comes into the City for pigeons.

Hackensack Meadow Group

In August and September the meadows and marshlands in the vicinity of Hackensack, New Jersey, are teeming with bird-life. In the group showing these Hackensack meadows are swallows preparing to migrate southward, bobolinks or "rice birds" in autumn plumage, red-winged blackbirds, rails, wood ducks and long-billed marsh wrens.

Wild Turkey Group

The wild turkey is a native of America and was once abundant in the wooded regions of the eastern portion of the United States, but is now very rare. It differs slightly in color from the Mexican bird, the ancestor of our common barnyard turkey, which was introduced from Mexico into Europe about 1530 and was brought by the colonists to America. (Reproduced from studies near Slaty Forks, West Virginia.)

Florida Great Blue Heron Group

The great blue heron usually nests in trees. The bird flies with its neck curved back on its body and because of this habit can readily be distinguished from the crane with which it is frequently confounded. (Reproduced from studies near St. Lucie, Florida.)

Water Turkey or "Snake-bird" Group

In the "bonnets" or yellow pond-lily swamps with cypresses and cabbage palmettoes, the shy water turkey builds its nest. It receives the name "turkey" from its turkey-like tail and the title "snake-bird" from its habit of swimming with only the long slender neck above water. (Reproduced from studies near St. Lucie, Florida.)

A PORTION OF THE EGRET GROUP

As shown here, the birds carry their plumes only during the nesting season; killing the parents means the slow starvation of the young.

Sandhill Crane Group

The sandhill crane builds its nest of reeds in the water. Unlike the herons in this respect, it differs also in its manner of flight, always stretching its neck well when on the wing. (Reproduced from studies on the Kissimmee Prairies of Florida.)

Brown Pelican Group

Pelican Island on the Indian River of Florida has been made a reservation by the United States Government and these grotesque birds may now breed there undisturbed. The view shows a section of the island at the height of the nesting season. Notwithstanding the hundreds of young birds that are clamoring for food, observation has shown that the parent bird can

BROWN PELICAN GROUP

One of the Habitat Groups of North American Birds.

pick out its own offspring with unfailing accuracy. (Reproduced from studies at Pelican Island, Florida.)

American Egret Group

This beautiful bird has been brought to the verge of extinction in this country through the use of its "aigrette plumes" for millinery purposes, and is now confined to a few protected rookeries of the South. The birds have these plumes only during the nesting season, at which time the death of the parent means the starvation of the young. (Reproduced from studies in a rookery of South Carolina.)

Turkey Vulture Group

The turkey vulture, or "buzzard," is one of the best-known birds of the South, where it performs a valuable service in acting as the scavenger of the streets. On this account it is protected by law and by public sentiment and has become both abundant and tame. (Reproduced from studies at Plummer Island in the Potomac River, near Washington.)

California Condor Group

The California condor is the largest and one of the rarest of North-American birds. It is not so heavy as the condor of the Andes, but has a slightly greater spread of wing, eight and one-half to eleven feet. In the group the visitor is supposed to be standing in the interior of the cave where the bird has its nest and is looking down on the river of the cañon which is more than five thousand feet below. (Reproduced from studies in Piru Cañon, California.)

Brandt's Cormorant Group

The foreground of the group shows a detail of the island that is painted in the background. The young birds are feeding, and it will be noticed that one fledgling is reaching well down the mother's throat after the predigested food. (Reproduced from studies at Monterey, California.)

San Joaquin Valley Group

Formerly this area was an arid place with a characteristic desert bird fauna. Now the ranchmen have irrigated the land and aquatic bird-life abounds. This group is a good illustration of the influence of man on the bird-life of a region.

Flamingo Group

In the breeding season the flamingoes congregate in great numbers in their rookeries. There were estimated to be two thousand nests in this colony. The flamingoes construct their nests by scooping up mud with their bills and packing it down by means of bills and feet. The nests are raised to a height of twelve or fourteen inches; this protects eggs and young from disasters due to high water. Only one egg is laid in the nest, and the young is born covered with down like a young duck and is fed by the mother on predigested food. The brilliant plumage of the adult is not acquired until the fifth or sixth moult. (Reproduced from studies in the Bahama Islands.)

Booby and Man-of-War Bird Group

In this group is shown a portion of a coral islet on which three thousand boobies and four hundred man-of-war birds were nesting, the former on the ground, the latter in the sea grape bushes. (Reproduced from studies in the Bahama Islands.)

Florida Rookery Group

The abundance of bird-life in one of these rookeries is quite astounding. In this group are roseate spoonbills, snowy egrets, American egrets, little blue herons, Louisiana herons, ibises, cormorants, and water turkeys. Because of the great inaccessibility of this island it has been one of the last places to escape the depredations of the plume-hunter. (Reproduced from studies in the Everglades of Florida.)

Golden Eagle Group

The golden eagle is one of the most widely distributed of birds. In North America it is now most common in the region from the Rockies to the Pacific Coast, although it is found as far east as Maine. Stories to the contrary notwithstanding, the eagle never attacks man, even though the nest is approached.

Its food consists of rabbits, squirrels, woodchucks, and occasionally sheep. (Reproduced from studies near Bates Hole, Wyoming.)

Whistling Swan and Whooping Crane

These two groups have recently been added, though provision was made for them in the original plans for this gallery. The whooping crane was exterminated so rapidly that not only was it impossible to obtain a nest and young, but it was necessary to use old birds taken many years ago.

Klamath Lake Group

The abundance of bird-life in this western lake beneath Mt. Shasta, which is seen in the center of the background, is astonishing. Here is an example of how the normal nesting habits of a bird may be changed by its being driven into a different locality. In the group are white pelicans which usually make a nest of pebbles, Caspian terns, which commonly build their nests on sand, and cormorants that nest on rocks, all nesting together here on the tule or rush islets of the lake. (Reproduced from studies at Klamath Lake, Oregon.)

Arctic-Alpine Bird Life Group

The scene represented in this group is above timber-line on the crest of the Canadian Rockies, 8,000 feet above the sea. Although these mountains are in the temperate region, the altitude gives climatic conditions that would be found in the Far North, and the bird-life is arctic in character. Here are nesting the white-tailed ptarmigan, rosy snow finches and pipits. (Reproduced from studies in the Canadian Rockies.)

Sage Grouse Group

This group shows a stretch of Western plateau covered with sage brush. In this brush is seen the male sage grouse strutting and wooing a mate. (Reproduced from studies at Medicine Bow, Wyoming.)

Prairie Chicken Group

The prairie chickens are akin to the common grouse. The group represents a typical scene during the mating season. The male birds go through most surprising antics in their efforts to attract the females. They inflate the orange-colored sacs on the sides of their necks, dancing and strutting about and uttering a loud, resonant, booming note. (Reproduced from studies near Halsey, Nebraska.)

Love-making of the prairie chicken. In this position and with orange-like air sacks inflated, he produces a booming sound which may carry a distance of two miles.

Wild Goose Group

The wild goose is one of the first birds to migrate north in the spring. It nests among the lakes of Canada even before the ice is melted. To secure the young birds for this group it was necessary to hatch the eggs of the wild goose under a hen, so difficult is it to find the young in nature. (Reproduced from studies made at Crane Lake, Saskatchewan, Canada.)

Grebe Group

The grebes are aquatic birds which build their nests in the water. During the incubation period the parent bird usually covers the eggs with grass and reeds when leaving the nest. Nesting at the same lake with the grebes was the redhead, a duck which lays from fifteen to twenty eggs. (Reproduced from studies made at Crane Lake, Saskatchewan, Canada.)

Loon Group

The loon is justly famed for its skill as a diver, and can swim with great speed under water. Its weird call is a familiar sound on the northern New England lakes. Many loons pass the winter at sea fifty miles or more from land. (Reproduced from studies at Lake Umbagog, New Hampshire.)

This rocky island thirty miles from shore in the Gulf of St. Lawrence affords some protection to the sea birds which still nest in great

Photo by Beasley

THE FLEA AND THE DOG

One of the enlarged models made by the late Ignaz Matausch from his original studies and now shown in a case devoted to Insect Carriers of Disease, in the Hall of Public Health. The dog is a fine example of the Chihuahua Dog, a pigmy breed, much esteemed in Mexico. It may be seen in the Darwin Hall.

numbers on and in its cliffs, although the colony is a mere shadow of what it was even fifty years ago. Seven species are shown nesting in the group—the razor-billed auk, Leach's petrel, gannet, puffin, kittiwake gull, common murre and Brunnich's murre. (Reproduced from studies at Bird Rock, Gulf of St. Lawrence.) This was the American Museum's first habitat group.

Bird Rock Group

[*Return to the South Pavilion containing the apes and monkeys.*]

West Corridor

PUBLIC HEALTH

Returning to the South Pavilion where the monkeys are, and passing to the right, we enter the *West Corridor* containing the exhibits of the Department of Public Health.

The Hall of Public Health is dominated by a bronze bust of Louis Pasteur, the founder of scientific bacteriology and preventive medicine, which was presented to the Museum through the courtesy of the Pasteur Institute of Paris. Near the head of the stairway is a reading table where pamphlets bearing on insect-borne disease and other public-health problems may be consulted.

Water Supply

The first section of the exhibit deals with the natural history of water supply as it affects the life and health of man. The large frieze at the entrance to the corridor on the left illustrates the primary source of water supply, the sea, the clouds, and the secondary sources, rivers and lakes. Diagrams, models, and a relief map show the variations in rainfall at different points in the United States. Relief maps of the region about Clinton, Massachusetts, before and after the construction of the Wachusett Reservoir for the water supply of Boston, show the way in which surface water supplies are collected by impounding streams, and a model of a well sunk through impervious clay or rock down to water-bearing strata shows how ground-water supplies are obtained. A series of samples and models illustrate the variation in composition which occur in natural waters, from the swamps of Virginia to the deep wells of Iowa and the turbid rivers of the Ohio Valley.

Some of the principal micro-organisms, Algæ and Protozoa, which grow in reservoirs and impart tastes and odors to water are represented by a series of glass models. The effect produced by the pollution of water by disease germs is illustrated by relief maps and diagrams showing the course of famous typhoid and cholera epidemics. Models are displayed which illustrate the purification of water by storage, filtration, and disinfection, the filter models being elaborate representations

of the plants at Little Falls, N. J., and Albany, N. Y. Diagrams indicate the results of water purification as measured in the saving of human life. Finally a series of five large relief maps show the growth and development of the water supply of New York City.

Disposal of City Wastes

Following the water-supply exhibit is a series of models illustrating the dangers from improper disposal of the liquid wastes of the city and how they may be avoided. Actual points of danger in the neighborhood of New York are shown where polluted harbor waters, bathing-places, and shellfish beds constitute a menace to health. Modern methods for the treatment of sewage on scientific lines are illustrated by a series of models of screens, sedimentation tanks, and filter beds of various types.

Bacteria

The cases near the window are devoted to the group of Bacteria, especially in their relation to human life. Glass models show the various shapes and relative sizes of these minute forms, and in particular of the principal types which cause disease. In a nearby case are displayed actual colonies of a number of species of bacteria, including some which produce disease and others which are beneficial to man by their effect upon soil fertility or from the fact that they may be utilized in the production of substances useful as foods or in the arts. A group of transparencies at the window shows some of the more important disease bacteria as they appear under the microscope.

Insects and Disease

Another series of exhibits deals with the transmission of disease by insects, notably by the fly and flea and by the mosquito. The most striking features are greatly enlarged models of the fly, the flea, and the louse. These, the finest models of the kind ever made, were prepared by the late Ignaz Matausch from his original studies, and required several years of constant, exacting labor.

The egg, larva and pupa of the fly, and the eggs of the louse are also shown.

Models in the wall case deal with the life history of the fly, showing its various stages in their natural size and actual habitat, and illustrate the large numbers of flies which may breed in a single pound of manure and the enormous progeny which may spring from a single pair and their descendants during the breeding season.

The deadly work of the fly in carrying typhoid fever is illustrated by graphic presentations of typhoid statistics of the Spanish-American War and of the relation between flies and "summer disease" of children, as worked out by the Association for Improving the Condition of the Poor in New York City.

Nearby are two models showing unsanitary and sanitary conditions on a small farm. In one, pools of stagnant water and uncovered manure heaps and general uncleanliness favor the breeding of mosquitoes and flies, while the open doors and windows give these insects free access to the house. In the other, the swampy land is drained and cultivated, the windows screened, the shallow dug well replaced by a driven well; the conditions are sanitary, and health and prosperity replace sickness and poverty.

Various types of traps for larvæ and adult flies are shown with models illustrating how fly-breeding may be prevented, how human wastes may be protected from their access, and how manure may be cared for so as not to be a medium for breeding flies.

A wall case on the right of the entrance to the hall shows a group of the natural enemies of the fly: the cock, phebe, swifts, the bat, spiders and centipedes, in characteristic surroundings as they may be seen in the corner of a New York State farm on a late August afternoon.

The Flea and Bubonic Plague

The relation of the flea and the rat to the terrible disease bubonic plague is illustrated in considerable detail. Wall charts picture the spread of the great historic epidemics of this disease, and reproductions of sixteenth and seventeenth century drawings show with what terror the Black Death was regarded in pre-scientific days. The chief carrier of the disease, the flea, is shown in a remarkable model, 120 times the length of the actual insect, and having the bulk of 1,728,000 fleas, prepared by Ignaz Matausch.

Specimens of some of the principal animals which harbor the plague germ and serve as reservoirs from which it is carried by the flea to man (the black, brown and roof rats, the wood rat and the California ground squirrel) are shown, and the manner in which the disease is disseminated is illustrated by a copy of a corner of a rat-infested house in California. The original from which this was copied, as well as many of the rats and squirrels, were obtained through the courtesy of the U. S. Public Health Service of Washington. A habitat group shows a typical family of ground squirrels on a rocky hillside in central California, during the breeding season in May. Preventive measures used against the plague are illustrated by models of a farm with buildings rat-proofed, of a rat-killing squad, equipped for work in San Francisco, of a ship at dock with rat-guards to prevent the access of rats to the shore, and by specimens of various types of rat traps.

In a window case are shown various stages of the common mosquito, Culex, as well as of Anopheles, the carrier of malaria, and Aedes, which is responsible for the spread of yellow fever. In the same case are specimens of other insect carriers, such as the flea, the bedbug and the

louse. Small cases flanking the windows contain specimens of the Glossinas, which transmit sleeping-sickness and the Nagana disease in Africa, and of the ticks which spread Texas fever of cattle and relapsing fever, African fever, and Rocky Mountain spotted fever of man. Nearby are shown maps indicating the area affected by the principal tick fever in the United States and a model of a dipping vat used in freeing animals from tick infestation.

Mosquitoes and Other Insect Carriers of Disease

A series of models and diagrams is devoted to the life history of the Anopheles mosquito and its relation to malaria. A relief map of the State of Arkansas illustrates the coincidence between low swampy lands and the prevalence of malaria, and another shows the heavy incidence of malaria in the vicinity of marshlands near Boston. A small relief map indicates the type and arrangement of drains used for lowering the water level and eliminating mosquito-breeding pools, and diagrams illustrate the progress made in mosquito control in New Jersey and the financial return which has resulted.

Mosquitoes and Malaria

A wall case devoted to the natural history of the mosquito illustrates the world distribution and seasonal prevalence of malaria and yellow fever in relation to the habits of their mosquito hosts, the breeding-places of mosquitoes, the life history (shown by specimens) and the money cost of malaria to the United States. Here are also shown some of the practical methods of control by ditching, oiling, stocking with fish, and encouraging enemies such as the bat, bite cures, and repellents and finally the practical results in the reduction of malaria which have been obtained in Italy.

Malaria and Yellow Fever

A second mosquito case contains a series of small-scale models, attractively worked out by Otto Block, illustrating some of the methods and results of tropical sanitation as applied to the mosquito-borne diseases, malaria and yellow fever. A hospital at Panama is shown as it was during the French regime with mosquito-breeding pools all about and with the legs of the beds and the flower pots set in dishes of water to keep off the ants. In contrast there is illustrated a modern hospital with all stagnant water removed, and wards screened and ventilated. Other models show the sanitary squads on the Isthmus which fought the yellow-fever mosquito in the town by fumigation, and the malarial mosquito in the country by ditching and oiling. The same case contains oil paintings of the completed canal and of the camp near Havana where the secret of the transmission of yellow fever was discovered and the foundations of tropical sanitation laid in 1900. Photographs

Control of Mosquito-borne Disease

of the four American Army officers, Reed, Carroll, Lazear, and Agramonte, to whose researches this advance is due, are hung upon the wall near by.

Military Hygiene

One wall case is devoted to the subject of military hygiene, which has become of such immediate moment and has, on the whole, been so successfully solved during the Great War. Diagrams illustrate the relative deadliness of disease germs and bullets in earlier wars; and their lesson is reinforced by a representation of the relative importance from injuries in action and from typhoid fever during the Spanish War. One company, confronted by a cannon, suffers the loss of one man wounded, while the other, facing a tube of typhoid germs, has one dead and thirteen in the hospital. Other models show how camp wastes are disposed of, and how water supply is sterilized, and still others, how the soldier's tent is protected against mosquitoes and how a field hospital is equipped. The field ration of the soldier and the preparation of anti-typhoid vaccine are illustrated by specimens and models.

Vital Resistance and Disease

Two tree trunks, one normal and the other infested with fungi as a result of mechanical injury, illustrate the important fact that the normal plant or animal is able to resist disease, while anything which tends to lower vital resistance may open the way for the invasion of pathogenic germs.

Audubonniana

The collection of Audubonniana, or objects relating to the life and works of John J. Audubon, presented to the Museum by his granddaughters, Maria R. and Florence Audubon, occupies the stairway hall. It includes original sketches and paintings by Audubon and his sons, illustrations in various stages from the Quadrupeds of North America, and some of the copper plates of the "Birds of North America." The most important piece is a large painting of a covey of "English" pheasants, flushed by a dog. Of more personal interest is the gun carried by Audubon on many of his expeditions and a favorite buckskin hunting coat.

Near by is a portrait of Robert Havell, the engraver and publisher of the first edition of Audubon's, Birds of America.

Southwest Wing

INDIANS OF SOUTH AMERICA

Indians of South America

Passing through the west corridor, where the exhibit of the Department of Public Health is installed, and on into the adjoining hall to the west, we find the collections from South America. The greater part of the hall is filled with archæological material illustrating the various forms of culture existing in Colombia, Ecuador, Peru, Bolivia, and Chile, in prehistoric times. The remains found in Peru, in parts of Central America, and in Mexico show a degree of culture far in advance of that attained in any other part

PIECES OF CLOTH FOUND WITH PERUVIAN MUMMIES

The prehistoric Peruvians were familiar with modern weaves, including the finest gobelins and produced highly decorative effects by harmonized colors and a repetition of woven-in designs. The Museum's collection of mummy cloths is one of the largest in the world, and is much used by teachers and students of art

of this continent in prehistoric times. Unlike the ancient peoples of Mexico and Central America the Peruvians had no written language. They were tillers of the soil and raised maize, potatoes, oca, quinua, beans, coca, and cotton. They had domesticated the llama, which was used as a beast of burden. They excelled in the manufacture and decoration of pottery vessels, in metal work, and in textile fabrics. In the case

PERUVIAN MUMMY BUNDLES AND MUMMY

The ancient Peruvians wrapped their dead in fabrics of fine cotton and wool, then covering with a sack of strong cloth. The mummy "bundle" thus produced was often given a "false head" of cloth filled with cotton or vegetable fibre. Climatic conditions in Peru have preserved these mummies and their wrappings during many centuries.

directly in front of the entrance are displayed gold and silver objects, such as beads, cups, pins and ear ornaments, which show the high degree of skill attained in the beating, soldering and casting of metals. In weaving they were perhaps preeminent among prehistoric peoples, many of their specimens exhibited here being unsurpassed at the present day. The materials used were cotton and the wool of the llama, alpaca and vicuna. In the first cases on the right are examples of these textiles with looms and shuttles. [The musical instruments of ancient Peru are discussed in *Guide Leaflet* No. 11, and *Guide Leaflet* No. 46, Peruvian Art, deals with the meaning of the figures shown on textiles and pottery.]

Gold and Silver

Textiles

The alcove cases are geographically arranged, showing exhibits from the north toward the south of South America, then up into the interior of the continent. In the wall cases extending across the entire western end of the hall will be found a remarkable collection from Nazca, Peru. The prehistoric people of Nazca excelled as colorists, particularly in the decoration of their pottery vessels, which are certainly the most beautiful so far discovered in South America.

AN EXAMPLE OF NAZCA POTTERY

On the south side of the hall is shown a collection from Ica, Peru. In this exhibit are some rare and beautiful shawl-like garments of these prehistoric people, in a good state of preservation.

TREPHINED SKULLS FROM PREHISTORIC PERUVIAN GRAVES

The special exhibits in the gallery rail cases include quipus used to keep accounts, charms and medicines, coca which was chewed with lime, and shells that were found in mummy bundles and in the graves. A number of the chicha jars are on exhibition on top of the cases.

Trephined Skulls

In the first case to the left (south side) is a collection of skulls showing many examples of trephining, artificial deformation, and pathological conditions, together with a number of normal Peruvian skulls for comparison.

Mummy Bundles

The wall case at the left of the entrance contains mummy bundles and various objects showing the burial customs of the Peruvians. In no part of America are found so many and so extensive burial places as in the coast region of Peru. Here were interred countless thousands of the ancient dead. In the *huacas* or graves, with the bodies, were placed such articles as had been most useful and highly prized during life, and such as it was considered would be most serviceable in a future life.

To this custom we are indebted for no small part of our knowledge of the daily life of the ancient Peruvians. From the mummy bundles and graves all the objects in the extensive collections in this hall, illustrating their civilization, have been obtained. The wonderful state of preservation shown in the textile fabrics and other perishable materials from the coast regions is due to the extreme dryness of the climate and the nitrous character of the soil. [See *Guide Leaflet* No. 24.]

Chilean Mummy

The mummy in the case at the west end of the room was found in a copper mine at Chuquicamata, Chile. The body is that of an Indian miner who was killed by the falling in of rocks and earth while engaged in getting out the copper ore (atacamite) used by the Indians in making implements and ornaments in prehistoric times. The tissues of the body have been preserved by copper salts with which it is impregnated. The implements he was using at the time of his death are shown beside him in the case.

On the south side of the hall are the ethnological collections from Brazil, British Guiana, Paraguay and Colombia. War implements, basketry, featherwork, and musical instruments, etc., are arranged in these cases.

CHINESE AND SIBERIAN COLLECTIONS

If we pass on into the hall at the extreme west end of the building, we find collections from eastern and northern Asia. The arrangement is geographical. Specimens illustrating the culture, industries, religion, and manufactures of China are on the left; others showing the mode of living, the costumes, and the war implements of Siberia are on the right. The furwork, cos-

Collections from Asia

ANCIENT CHINESE BRONZES

tumes, and rugs of the people of East Siberia reveal remarkable skill in workmanship. Two models show respectively summer and winter scenes in Siberia. A small model in one of the cases to the left shows the manner of making pottery. A series of frames in the rear contain pieces of various kinds of fabrics and patterns illustrating weaving and woodwork ornaments.

The collections deal mainly with the everyday life of the modern Chinese and have a special value, as they were made just before the sweeping changes of the last few years took place. These abolished many of the customs in which these objects were used; for example, the series of weapons and objects showing the tests to which a soldier was submitted on entering the army have been rendered obsolete by the introduction of modern weapons and tactics. Bamboo, porcelain, basketry, inlaid work, cloisonne enamel, agricultural implements,

BLACK HELMET OR CAMEO SHELL

From the Morgan Collection

carvings in wood, ivory, and stone, and embroidery are shown to advantage.

A special collection of great value is found in the ancient bronzes and pottery shown in the adjoining tower room.

West Wing

SHELLS

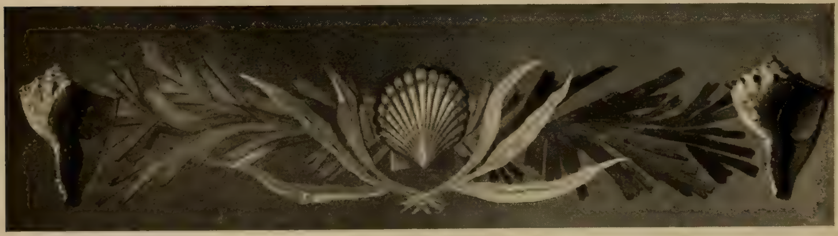
The collection of shells installed in the *West Wing* contains altogether about 100,000 specimens representative of nearly 15,000 species. These show extraordinary range of color and ornamentation. The arrangement of the collection is as follows: first, in the south wall cases a series showing briefly the classification of mollusks; second, in the eight table cases at the north and south ends of the hall the collections of land shells; third, in the upright railing cases the bivalves or mollusks which have two shells like the common clam; fourth, in the metallic cases the univalves, mollusks which have only one valve or shell like the snails; fifth, special exhibits of shells in the north wall cases. Other cases contain exhibits illustrating the anatomy and habits of mollusks; colored transparencies show them in their habitats. A series of colored photographs (N. end Rail Cases) illustrates stages in the pearl-button industry of the U. S.

Facing the entrance is a huge shell of the giant clam, *Tridacna*, measuring 43 by 27 inches and weighing 579 pounds, one of the largest examples on record.

Short descriptive group labels will be found in the cases, and on the walls, picture labels of important families of shells, together with small Maps of Distribution defining the occurrence of the same throughout the world.

An interesting collection of deformed shells is seen in the north case, and a series illustrating the ornamental uses of shells. Cases of especial beauty in their shell contents are those holding *Murex, Fusus, Volute, Conus, Oliva, Strombus, Cypraea, Trixia.*

[*Return to the South Pavilion, containing the apes and monkeys.*]



DECORATION FROM THE SHELL HALL

MAMMALS OF THE WORLD

Continuing east from the hall where the apes and monkeys are, we pass the elevators, to enter the hall of the *Southeast Wing*, devoted mainly to a series of exhibits illustrating the characters of mammals, their principal groups, or orders, the main sub-divisions of these, known as families, and various interesting peculiarities of habits and structure. Each family is, so far as possible, represented by a mounted specimen and a skeleton. Walking around the room from left to right one passes from the egg-laying Platypus to man, represented by the figure of an Australian native, armed with the characteristic boomerang. Incidentally one sees among other things the modifications of form and structure for various modes of locomotion, notices the superiority in brain of mammals over other vertebrates, learns that animals that outwardly look alike may be very distantly related, sees illustrations of albinism and melanism, and is shown how the coat of the hare changes from brown to white.

Above the cases is a frieze representing marine scenes, which serves as a background for groups of porpoises, dolphins, and other small members of the whale family. The most striking object in the hall is the life-size model of a sulphur-bottom whale, seventy-nine feet in length.

Model of Sulphur-bottom Whale

The original of this specimen was captured in Newfoundland, and the model is accurately reproduced from careful measurements. This huge creature is not only the largest of living animals, but, so far as we know, the largest animal that has ever lived: a specimen of this size weighs from sixty to seventy tons, about twice as much as *Brontosaurus*. As can be seen by examining the models of a whale's head attached to the pillar, the whalebone which takes the place of teeth hangs in great plates from the inside of the upper jaw. This whalebone acts as a strainer in the mouth of the whale, and extracts the small animals from the sea water which the whale takes into his mouth when feeding. The food consists mostly of tiny crustaceans less than an inch in length. Although whales and porpoises live in the water, they are not fishes, but are warm-blooded and breathe by means of lungs, not gills. The whale must come to the surface to breathe and the so-called "spouting" is merely the result of the warm air being expelled from the lungs when he breathes. A whale does not spout *water*, as is commonly supposed. Models to scale of the other whalebone whales, and the toothed sperm whale, and reproductions of smaller whales and porpoises are hung near for comparison.

The plans for the next addition to the Museum building include a large hall to contain whales and other marine animals.

In the railing cases are exhibits which aim to give the visitor a general view of the enormous class of insects. This series is, at present, being extended and improved. When finished, it will include representatives of all the principal families, exotic as well as native. A special exhibit of the common butterflies near New York City and another of the "Moths of the Limberlost" have been installed. There is also one showing butterflies found in North Temperate America. There are nearly half a million species of insects in the world so that, even when finished, this series can contain only a small part of the total. Furthermore, many of the species would fade rapidly if exposed to the light. The general study collection of insects is on the fifth floor, and while it is not on exhibition, the curators will be glad to show it to visitors who can make use of it. See the Southeast Pavilion for the study collection of local insects.

Southeast Pavilion

HALL OF INSECT LIFE

Insect Life

Proceeding east, we enter the *Insect Hall.* The installations in this hall point out the relationships, through origin and mode of life, of insects to each other and to the other members of the Animal Kingdom, especially to man. The exhibits are arranged in a continuous series, and are numbered so that we can easily follow the plan beginning at the pillar farthest to the left and making two complete circuits of the hall.

Importance of Insects

First is an introductory section illustrating by diagrams the importance of insects as shown (a) by the large number of species compared with other animals [there are more species of insects than of all other animals put together] and (b) by their great influence on human interests. In the United States, the economic loss by insects is more than five times as great as by fire, and there are more than twelve times as many deaths from insect-borne diseases as from railroad accidents. On the other hand, many of our crops and all beautiful flowers are largely dependent upon pollination by insects.

Classification of Insects

Following this are a number of sections illustrating the anatomy of insects, explaining the terms used in the classification of insects, and exhibiting typical examples of the principal families.

GROUP OF MIGRATORY BUTTERFLIES

After a number of sections devoted to general phases of entomology such as the relationships of insects to each other and to other invertebrates, the color of insects, the four stages of an insect's life history, and the seasonal activity of insects, a series of exhibits is given which shows the principal insects of special situations and plants. Under the former heading we note aquatic insects and those associated with decaying material.

General Information

The exhibits concerned with insects associated with special plants lay emphasis upon those of economic importance and are followed by a study of household insects, insects and disease, and insecticides. It is shown that man's efforts to combat noxious insects is supplemented by the activities of lower mammals, birds, fish, reptiles, and of insects themselves.

Although certain insects destroy plants, some plants destroy insects. These and other ecological interrelations of insects and plants, including pollination, are shown on the east side of the hall.

PART OF THE CICADA GROUP

Occupations of Insects

Among insects are found carpenters, masons, weavers, papermakers, and other sorts of laborers. The making of silk is one of the principal insect activities, and several sections are devoted to silk, looking at it from both the entomological and the human viewpoints.

Following this, such subjects as art, the Bible and other literature, medicine, and superstition in their relation to entomology are treated. Photographs and short biographies of prominent entomologists of the past are given.

Evolution is a large subject, but the principal points involved in the present-day theories are illustrated in a series of sections treating

such problems as mimicry, protective coloration, adaptation, variation, mutation, geographic distribution, selection, and inheritance (Mendelism).

Evolution of Insects

The north side of the hall is devoted to social insects and their relatives. Here are found several groups showing the activities of these interesting creatures.

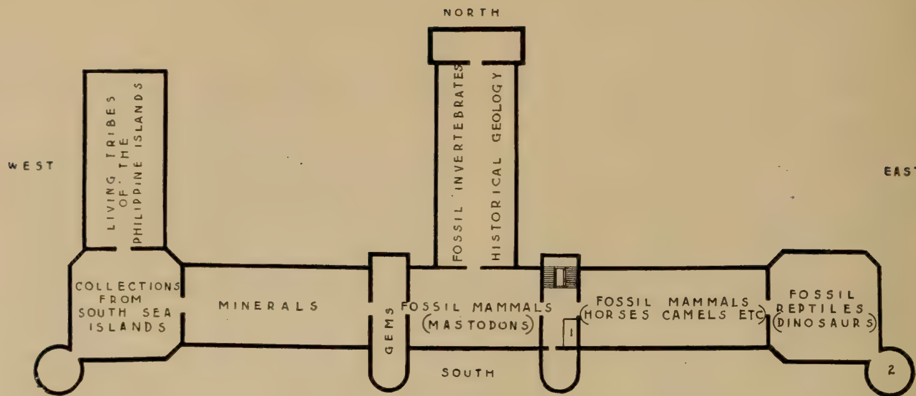
The final series includes a variety of things, being answers to the questions most frequently asked the curator by the general public.

Local Collection

Visitors desirous of studying the local insects more in detail are cordially invited to do by consulting the nearly complete collection to be found in this hall under the custody of the New York Entomological Society. It is primarily intended to be an aid in identification of specimens and is not a part of the general exhibition series.

[*Return to the elevators and ascend to the Fourth Floor.*]

CECROPIA MOTH



1. Elevators
2. Fossil Fishes

Fourth Floor

FOREWORD ON FOSSIL VERTEBRATES

In the *East Corridor,* and the *South Pavilion* at the left, as well as in the *East Wing* and *Southeast Pavilion* at the right, are displayed the fossil mammals, reptiles, and fishes.

In a general way, fossils are the petrified remains of plants or animals that lived at some past period of the earth's history. In many instances we have not the objects themselves, but only their casts or impressions in the rocks. This is particularly the case with shells. Sometimes, as with the bones of the great Irish elk, the objects have been buried in swamps or bogs, and in a few rare instances, as with the mammoth and woolly rhinoceros, entire animals have been preserved for thousands of years in ice or frozen mud. Fossils are found in localities where the dead animals or plants have gradually been buried under layers of sediment to such a depth that they come in contact with the mineral waters of the earth and finally become petrified. Later through subsequent upheaval and erosion they are again brought to or near the surface of the earth. Petrifaction is the slow replacement of animal or vegetable material by such minerals as carbonate of lime or silica. The process is very slow and for this reason flesh is never petrified. Fossil beds are found in every continent. In our own country, Texas, Montana, Wyoming, and the Bad Lands of South Dakota are famous for their large fossil beds, and many of the finest and rarest fossils in the Museum were obtained in these localities.

As it takes thousands of years for the various layers of earth to accumulate over the bones, and for the latter to become petrified, the study of fossils and the strata in which they are found is an important aid in determining the age of the earth and the succession of life thereon.

The skeletons exhibited in these halls are of animals which lived from 30,000 to 20,000,000 years ago. To prepare a specimen for exhibition the matrix in which the bones are imbedded is carefully chipped away and the missing parts restored in cement and plaster. The bones are then assembled as in life. In the specimens on exhibition the restored parts differ in color from the original parts of the skeleton and can readily be distinguished.

As a whole, the Museum collections of fossil vertebrates are believed to be the finest in the world, if we take into consideration not merely numbers, but also variety, quality and perfected methods of preparation and exhibition. The collections illustrating the evolution of the horse are probably equal to those of all other institutions combined. The collections of Permian reptiles, of Jurassic and Cretaceous dinosaurs, of turtles, of North American Tertiary mammals, and of extinct mammals of South America, are likewise of the first rank. There are more than ninety complete skeletons on exhibition, several hundred skulls and nearly two thousand jaws or other parts of various species. About ten times this number are in storage, reserved for study and research, or not yet prepared for exhibition.

East Corridor

FOSSIL FISHLIKE LIZARDS

Directly in front of the elevator is a wall case in which the most recently acquired specimens are placed. The cases attached to the wall near the stairway contain specimens of huge marine fishlike lizards, which show the tremendous pressure to which fossils are often subjected and the fragmentary condition in which they are found.

South Pavilion

HALL OF THE AGE OF MAN

The *South Pavilion* is devoted to early man, represented by a series of casts of the more noteworthy specimens, and to his contemporaries, the mammoths and mastodons and the giant ground sloths of South America.

On the left is a series of modern skeletons illustrating the evolution of the horse under the hand of man. Here are such extremes as the Shetland pony, only two feet ten inches high, and the rough-boned draught horse, which stands six feet one inch in height. Contrast these with the slender-limbed "Sysonby" the famous race horse, and the Arabian stallion "Nimr." The horse

Skeletons of Modern Horses

THE LA BREA ASPHALT TRAP

And how it caught the Pleistocene Mammals.

EVOLUTION OF THE HORSE
One of the panels showing the evolution of feet and skull.

THE PLEISTOCENE
First of a series of Murals by Charles R. Knight,

lover will also be interested in the osteological collections in the wall cases which show how to tell the age of horses through the growth and development of the teeth.

Fossil Mammals of South America

Beyond the Horse exhibit on the left are fossils from South America, the most striking of which is the group of giant ground sloths. There are also good examples of the Glyptodon, a gigantic relative of the armadillo, of the camel-like *Macrauchenia,* the rhinoceros-like *Toxodon,* and other strange extinct animals which evolved in South America during the Age of Mammals, when it was an island continent, as Australia is to-day. Here, too, is the great sabre-tooth tiger, one of the host of northern animals that invaded the southern continent upon its union with the northern world, and swept before them to extinction most of its ancient inhabitants.

In the center of the hall is a small collection of fossil remains of man illustrating what is known of the prehistoric record of our own race.

Warren Mastodon

The principal exhibits on the north side of the hall are the mammoths and mastodons and the series of skulls showing the evolution of the elephant. The "Warren Mastodon" is a classic specimen. It was found near Newburgh, N.Y., in 1846, and is the finest specimen of its kind that has ever been discovered. Next to it is a fine skeleton of the mammoth; portions of skin, hair and other fragments of a mammoth carcass discovered in Alaska are also shown. While modern elephants are confined to portions of Asia and Africa, fossil remains of elephants and mastodons show that, at one time or another in the past, they were found over the greater part of the northern hemisphere.

Jumbo

The skeleton of an African elephant, the once famous Jumbo, whose name has been embodied in the English language as a term for anything unusually large, is shown for comparison with its extinct relatives.

[See *Handbook* No. 4, *Animals of the Past,* and *Guide Leaflet* No. 43, *Mammoths and Mastodons.*]

AGE IN EUROPE
for the Quaternary Hall. Hall of the Age of Man.

SOUTHEAST WING

HALL OF THE AGE OF MAMMALS

FOSSIL MAMMALS OF THE TERTIARY PERIOD

Return to the East Corridor and continue into the *Southeast Wing* or Tertiary Hall which contains the Fossil Mammals of the Tertiary Period.

The geological age to which the fossil shown in this hall belong covers a period of from 100,000 to 3,000,000 years. At each side of the entrance are charts indicating the successive periods of time from the Triassic to the Tertiary, and the animal life which pertained to each. Careful guides and exhaustive cards of explanation, photographs, and window transparencies combine to make the entire exhibit illuminative and interesting.

The particular feature of this hall is the wonderful series in the cases by the entrance and in the first alcove on the right showing the evolution of the horse in nature. The Museum is justly proud of this collection. Not only is it the largest and finest series of fossil horse skeletons in the world, but it is larger than the combined collections of all other institutions, and it contains the earliest known ancestors of the horse, the little four-toed *Eohippus*, which was no bigger than a fox and on four toes scampered over Tertiary rocks. As will be seen by an examination of the skeletons of the horse and man, the modern horse walks on the tip of his middle finger and toe. The front hoof bone corresponds to the last joint of the third finger in the human hand, and the other bones of the leg correspond bone for bone with the structure of the finger, wrist and arm of man. The similarity in structure of the skeletons of horse and man is brought out in the exhibit of a rearing horse being controlled by man. A comparison of these two skeletons will show that although

Evolution of the Horse

very different in proportions the bone of the one correspond with the bones of the other. In the modern horse the remaining fingers or toes of the fore and hind foot have entirely disappeared, or remain only as vestiges, the so-called "splint bones." The structure of the modern horse shows that it developed from a five-toed ancestor. This ancestry has been traced back to the four-toed stage. [See *Guide Leaflet* No. 36. *The Evolution of the Horse.*]

Restoration of Eohippus, the four-toed horse. This ancestor of the modern horse, scarcely larger than the red fox, lived some three millions of years ago. It comes from the Lower Eocene of Wyoming and New Mexico.

In the wall case at the right of the entrance is given a synopsis of the evolution of the foot and skull of the horse and the geological age in which each stage is found. Across the alcove the visitor will find skeletons of *Eohippus,* the four-toed stage of the horse and the earliest form that has been discovered. These are specimen from the Wasatch and Wind River beds of Wyoming and may have lived 3,000,000 years ago. It is interesting to note that while there were no horses found in this country by the white settlers, America is the original home of the horse.

Passing from skeleton to skeleton the changes that have taken place in the development of the horse are easily distinguished. The exhibit is made more lifelike by plaster restorations of the animals and by water-color sketches showing primitive horses in their environment. These paintings and models are by Charles R. Knight. In the latter types of

the three-toed stage the two lateral toes have lost their original function of support and are gradually becoming vestiges. The three-toed horse in the center of the alcove is one of the most complete and finest examples that has ever been unearthed.

Opposite the horse exhibit on the other side of the hall are series of specimens illustrating the evolution of the camel, deer and other cloven-hoofed animals. These animals like the cow of to-day walked on the tips of the third and fourth fingers, and the gradual disappearance or reduction to useless vestiges of the other fingers and toes can be traced as in the horse series.

Camels

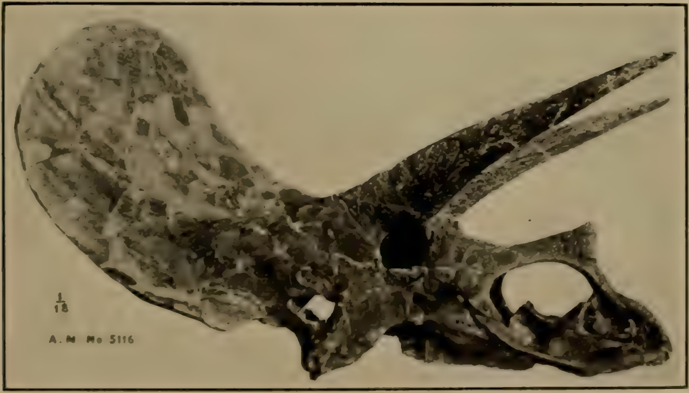
The large blocks showing groups of skeletons of early camels, skulls and bones of primitive ruminants in their natural position in the rock, show how these specimens are sometimes found and raise questions as to how they got there, more easily asked than answered. The giant pigs, or elotheres, and the pigmy hippopotamus will repay examination.

Giant Pigs and Pigmy Hippopotamus

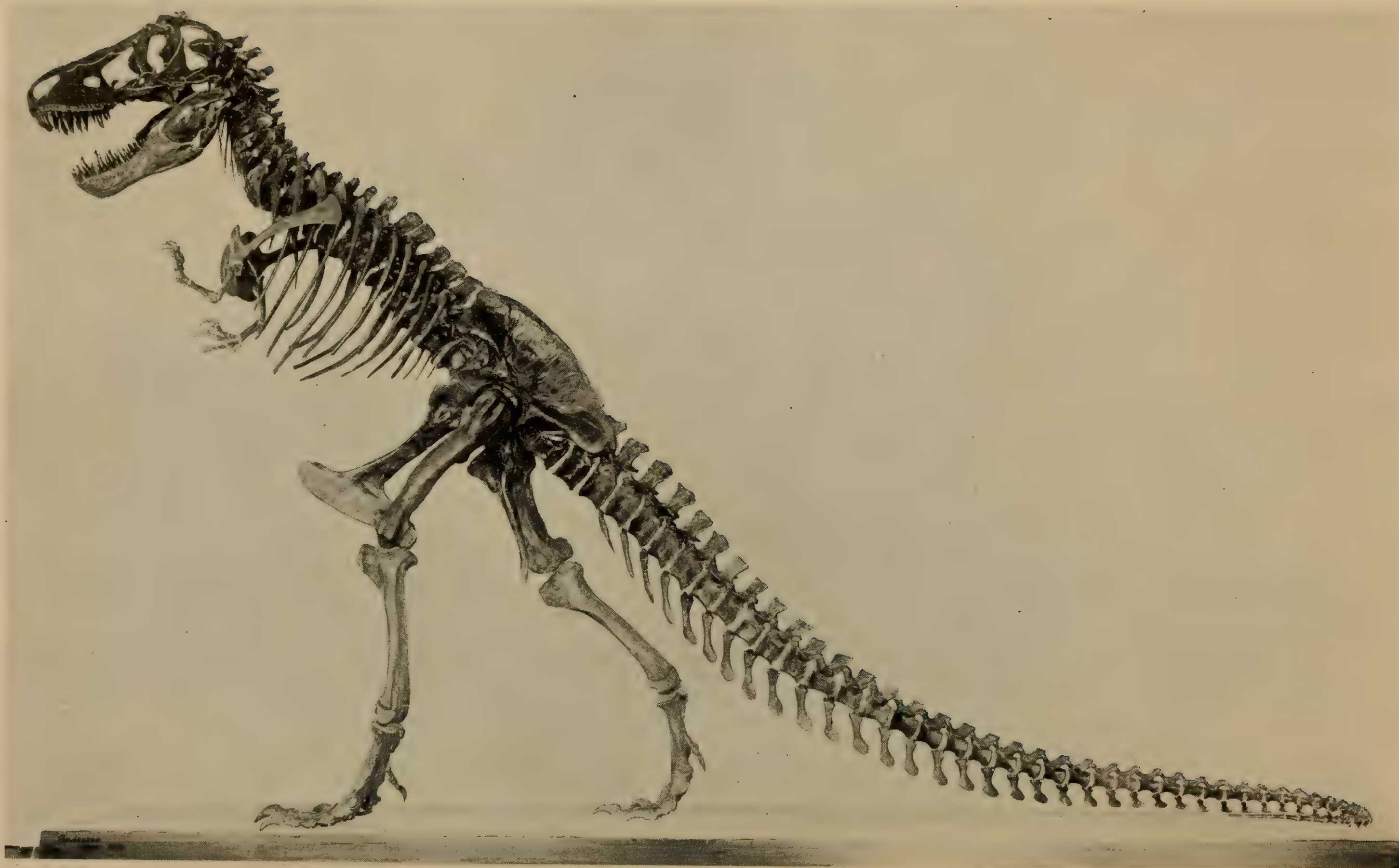
Rhinoceros

The primitive rhinoceros-like animals are shown near the center of the hall on the right. As here indicated great herds roamed over the fields in the Tertiary Period and their fossil remains are found imbedded in the sandstones and clays of the badland formations. Opposite these are shown the ancestors of the dogs, cats and other carnivores and the Creodonts or Primitive Carnivores of the early Tertiary. Next to these are the small mammals—the insectivores, rodents and marsupials; and the fossil lemurs and monkeys, fragmentary but interesting because of their bearing on the ancestry of man.

On the south side on the right are skeletons of titanotheres, on the left of uintatheres, huge extinct, horned animals peculiar to North America.



SKULL OF TRICERATOPS
A huge, two-horned Dinosaur suggesting a Rhinoceros



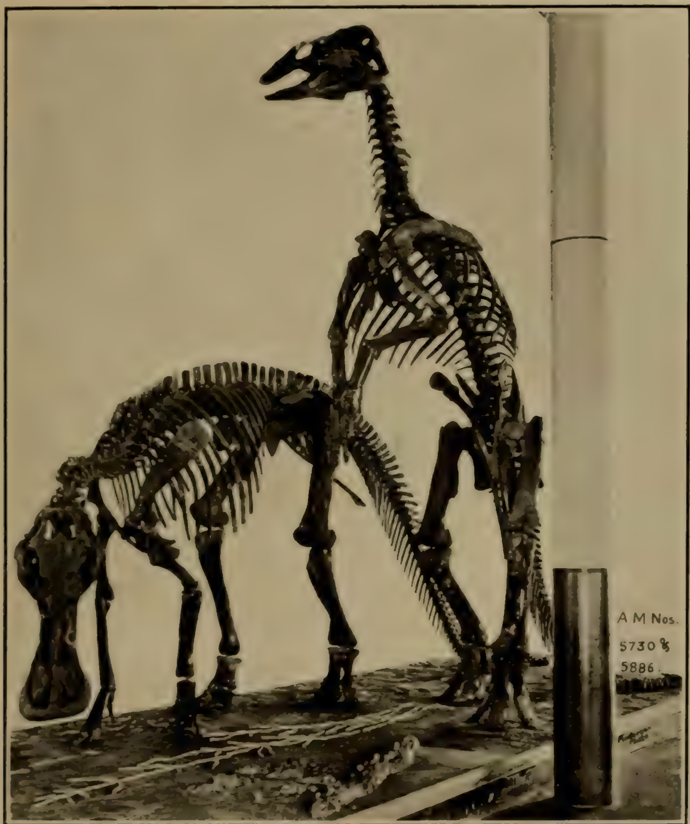
TYRANNOSAURUS, THE GIANT CARNIVOROUS DINOSAUR

A man would have been but a mouthful for this latest and largest of flesh-eating dinosaurs. This huge reptile lived during the Cretaceous Period, over three million years ago.

DINOSAUR HALL

FOSSIL REPTILES, AMPHIBIANS AND FISHES

The visitor now enters the *Southeast Pavilion* containing the dinosaurs and other fossil reptiles and also fishes. This hall is badly crowded



DUCK-BILLED DINOSAURS, TRACHODON

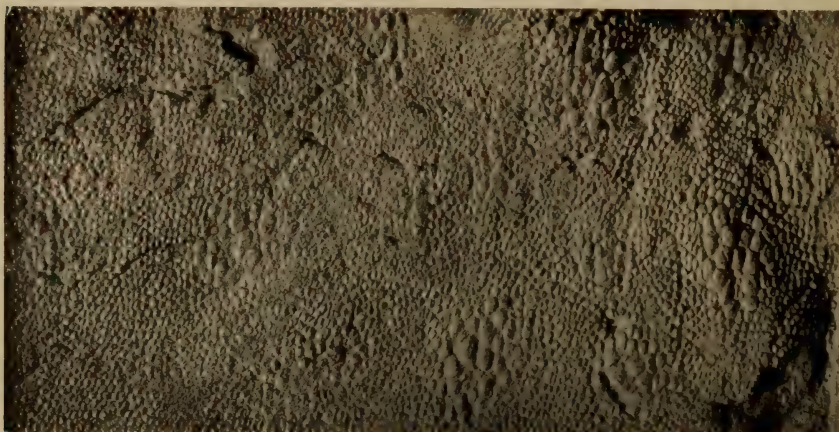
owing to the delay in constructing a new wing. These animals belong to a more ancient period than the specimens just examined. They lived from 3,000,000 to 10,000,000 years ago. They include the well-known dinosaurs of which the Museum has a large collection. In the wall case on the left is a portion of the skeleton of the dinosaur *Diplodocus;* this was the first of these specimens to be unearthed by the Museum, while on the right are the

The Dinosaur Diplodocus

skeletons of several kinds of dinosaurs obtained from the cretaceous formations of Alberta, and mounted as they lay when three million years ago, they settled to the bottom of a western lake and were gradually covered with sand and mud and slowly turned into stone.

The gigantic skeleton in the center of the hall is the huge extinct reptile, the dinosaur *Brontosaurus*, found in the Jurassic beds of Wyoming. It is the only mounted specimen of its kind in the world and more than two-thirds of the skeleton is the original petrified bone. It is sixty-six feet eight inches in length, sixteen feet in height and is estimated to have weighed, when alive,

Brontosaurus



Section of the skin of Trachodon showing the small scutes with which the animal was covered. About natural size.

thirty-five tons. Brontosaurus is one of the largest giant reptiles and as is indicated by its teeth was herbivorous, probably living on the rank water weeds of the nearly sea-level marshes of Wyoming. Contrasted with the herbivorous Brontosaurus is the carnivorous dimosaur *Allosaurus*, mounted to represent the animal feeding on the fallen carcass of a Brontosaurus, upon which it preyed. This is not a fanciful mounting, for these very skeletons were found in close proximity to each other in the Jurassic beds of Wyoming, and the skeleton of the fallen Brontosaurus shows gouges made by the teeth of Allosaurus as it tore the flesh from its victim.

Allosaurus

Near the Allosaurus group is a skeleton of *Tyrannosaurus*, the last and most powerful of the carnivorous dinosaurs. This huge carnivorous reptile rivalled the Brontosaurus in size and was far more active and ferocious, preying upon the duckbilled horned or armored dinosaurs which lived at the same time.

Tyrannosaurus

RESTORATION OF MONOCLONIUS

One of the Horned Dinosaurs shown in the Cretaceous Hall.

To the left of Brontosaurus are two complete specimens of the duck-billed dinosaur *Trachodon*. One shows the animal erect and standing on guard, while the other is shown feeding on shellfish and plants of the Cretaceous swamps of Montana.

Trachodon

Most wonderful perhaps of all the specimens shown here is a "mummy" of *Trachodon* in which the texture of the skin is preserved. The animal is lying on its back and, in spite of its crushed condition, its form is easily distinguishable. It probably died on a sand bank or near a shoal where the hot winds dried up the flesh until the skin adhered to the bones like a close-fitting glove, and was subsequently buried by a flood.

Mummied Dinosaur

[See *Handbook*, No. 5, *Dinosaurs*.]

RESTORATION OF NAOSAURUS

One of Nature's jokes. Professor Cope, who was also a joker, suggested that the high fin served as a sail, by means of which Naosaurus sailed over the lakes near which it llved.

Other specimens shown in the hall include the smaller carnivorous dinosaurs, the horned dinosaurs with, in one instance at least, a skull seven feet in length, and giant birds possessed of teeth. There is also the finback lizard, one of the most ancient of fossil reptiles; *Diadectes*, a reptile with a solid-boned skull and *Eryops*, a primitive amphibian. The finest collection of fossil turtles in the world will be found on the south side of the hall.

In the *Tower* of the Southeast Pavilion are displayed the fossil fishes which belong to a much earlier period than the mammals and reptiles, some of them having lived twenty to fifty millions of years ago. Many of these forerunners of backboned animals are quite unlike any living fishes and are probably only

Fossil Fishes

THE "FOSSIL AQUARIUM" IN THE FISH GALLERY

This shows what can be done to make these ancient forms appear as living. The group illustrates the typical "Age of Fishes," Devonian, in which the forms came from a single locality (Cromarty) and a single rock layer in the Old Red Sandstone of Scotland. The seaweed is also a restoration, modeled from impressions of the same age.

Cromarty is noteworthy, not merely for its deposits of Fossil Fishes, but for being the birthplace of Hugh Miller, whose discoveries and descriptions did so much to make the fishes known alike to the scientific world and the general public.

very indirectly related to them; some were small, curiously encased in shells; others, shown in the three cases in front of the visitor, attained large size and were evidently formidable creatures. One of them, in fact, *Dinichthys*, shown in the middle of the gallery, was probably among the most destructive creatures that ever lived in the sea. Its jaws were so strong that it could crush a plate of bone as thick as one's hand. Such an actual specimen, fractured in life and showing the marks of "teeth" is shown in a neighboring case.

The collection is so arranged that he who makes the tour can see the principal kinds of fossil fishes and is able, in a measure, to outline the history and pedigree of the entire group. He can trace the rise and fall of the early plate-covered fishes; the era of the sharks which on the one hand supplanted the earliest fishes and were in time replaced by the more efficient lungfishes and ganoids; the age of ganoids when the waters were filled with these enamel-scaled fishes; finally the age of the bony-fishes, or teleosts, the multitudinous forms of to-day, the herrings, cods, perches, whose methods of swimming, feeding and breeding are far more efficient than those of any of their predecessors.

Jaws of Giant Fossil Shark

Above the entrance are the jaws, "models," spreading nine feet, of a huge fossil shark in which the actual teeth are arranged as in the sharks of to-day, in the usual banks or rows—the teeth in the hinder rows serving to replace those in front, nature having dealt more kindly in the matter of teeth with sharks than with man. Such a shark probably measured from seventy to ninety feet and its race may well have become extinct, when for various reasons the enormous volume of food necessary to support it could not be maintained within its range of sea.

Fossil Aquarium

In the first alcove to the left, by the window, is a "fossil aquarium" in which a number of models of these earliest fishes are arranged in a group, as though alive in the sea.

Sharks

In the next alcove are the early fossil sharks which superseded the tribe of plated fishes just mentioned. These sharks had soft skeletons, simple fins and a number of other primitive features which lead to the belief that of all the higher fishes, and the higher back-boned animals therefore as well, were descended from them, their simpler structures becoming more complicated in many directions. In one of the early sharks here exhibited, impressions of soft parts such as muscles and gill filaments have been preserved.

Chimæroids

In the third alcove appear rare fossils of silver sharks or Chimæroids, which appear to have been developed from a primitive race of sharks. Curiously enough fossil egg capsules of these forms are sometimes preserved, and examples are here present.

In the neighboring cases are shown ancient lungfishes and ganoids—groups from which all land-living quadrupeds are believed to be descended.

Ganoids

In the fourth alcove are shown the ganoid fishes which dominated the waters during the Age of Reptiles. They were of many kinds and sizes, most of them with lozenge-shaped scales of bone, with enamelled surface. One of the few survivors "*Amia*" of this ancient group is here shown living "in a window aquarium," to give the visitor a clearer idea of the fishes of the "Middle Ages" of the world.

Teleosts

In the fifth alcove are the petrified fishes of the Age of Mammals. By this time nearly all of the primitive fishes, like sharks, lungfishes and ganoids, had become extinct; and the common forms were bony-fishes, or teleosts, closely related to our herrings, perches, mackerels and daces.

[*Return to the South Pavilion or Hall of Mastodons and Mammoths.*]

South Central Wing

GEOLOGY AND INVERTEBRATE PALÆONTOLOGY

Turning northward at the center of the Quaternary Hall containing the mastodons and mammoths, the visitor enters the *South Central Wing* of the building and is in the Hall of Geology and Invertebrate Palæontology. Palæontology is the science of the ancient life of the earth; its field is the study of the fossilized shells and other hard parts and the various kinds of imprints left by the animals formerly inhabiting the seas and lands, and preserved in deposits which now form our stratified rocks. As normally the upper layers of a series of strata are more recent than the lower, the fossils reveal the succession of life forms in the earth's crust and thus are of the highest value and interest to the student of historical geology. Since, however, the remains of only a small proportion of the animals living at a given period are permanently preserved in the marine, river, lake and subaerial deposits of that period, the geological record of animal and plant forms is far from complete. Inasmuch as invertebrate animals are far less free in their movements than the vertebrate forms, they are accepted as the best determinants of the geological age of a bed of rock, even when remains of both kinds are found together. Invertebrate life, too, appeared on the globe far earlier than vertebrate, and remains of certain species are abundant in the lowest "oldest" of our stratified rocks.

Meteorites

In the alcoves of the hall is the general collection of meteorites, which is one of the largest and most representative in this country, containing as it does specimens from about five hundred of the seven hundred falls and finds that are known throughout the world. Some of the principal features of our collection are:

Two thousand or more individual masses from the "stone shower" that fell near Holbrook, Arizona, in 1912. These have been arranged in a case by themselves.

The whole mass of Ysleta, a newly discovered "1914" iron meteorite, weighing 310 pounds from near the ancient village of Ysleta, New Mexico.

A series of polished and large etched slices of iron meteorites, including an entire section of the new Mt. Edith, Australia, mass, showing the Widmanstatten lines in great perfection, and polished slabs from several large stone meteorites. These are in a case by themselves which likewise contain several comparatively large entire single masses of some famous falls.

Types

In the desk cases down the center of the hall are the types and figured specimens used by James Hall, R. P. Whitfield and others in the original description and naming of species, or in their further elucidation.

Stratigraphic or Historical Geology

The specimens in the cases on the left or west side of the hall are being arranged to illustrate stratigraphic geology, beginning at the south (entrance) with the Archean rocks, which are the lowest and oldest of all and contain no fossils, advancing regularly through the Cambrian Ordovician, Silurian, Devonian, Carboniferous, Jurassic, Triassic, Cretaceous and Tertiary. Most of the specimens on exhibition are from American localities and the species are arranged according to their position in the scale of life, the lower, or simpler forms being placed first. The specimens shown are those particularly characteristic of the various horizons, the object being to give an idea of the general character of the life of different periods of the world's history. The ends of some of the cases contain large or striking fossils.

Biologic Geology

The specimens on the east, or right, side are being arranged to illustrate biologic geology, the classification and relationship of the plants and animals of past geologic times. The series starts with the plants and is followed by the various sub-divisions of the animal kingdom, again beginning with the lower, or simpler forms and continuing to the highest.

In the first alcove on the right is the stump and part of the roots of a large tree from an anthracite coal mine under Scranton, Pa. Millions

of years ago, in the geological period known as the Carboniferous, this tree grew upon the top of a thick swamp deposit of decaying vegetation which ultimately became a most valuable bed of coal. The stump was left in the roof of the mine when the coal was extracted for commercial and domestic uses. It fell to the floor years after the gallery had been abandoned and was discovered only through the chance visit of a miner.

Fossilized Tree Stump

Half way down on the east side is a desk case containing a series of rock specimens illustrating the geology of Manhattan Island. This is arranged geographically and shows the more prominent features of local geology from south to north.

Geology of Manhattan Island

The northeastern corner of the hall is devoted to the Copper Queen Mine Model and a series of ores and other specimens from the famous Bisbee-Warren copper district in southern Arizona. Two models have been prepared as a result of several years of extremely painstaking and skillful work. A large model, some 18 by 12 feet in dimensions, shows on a scale of twenty-four feet to the inch all the surface features and mine and other buildings over four of the principal mines (Holbrook, Spray, Gardiner and Lowell) belonging to the Copper Queen Consolidated Mining Company, while a painted background represents the surrounding mountains and the town of Bisbee. The sides of the model give vertical sections to the depth of about 1,200 feet illustrating the geology of the area and showing the general manner of getting out the ore and hunting for new deposits. There was produced in about 30 years (1880-1912) from the mines at Bisbee belonging to this company 7,729,922 tons of copper ore of an average copper content of 7.16%. The metal production in this period was

Copper Queen Mine Model and Exhibit

Copper—1,106,605,774 pounds (553,303 tons)
Gold —104,775 ounces Troy (8,731 pounds)
Silver —6,107,421 ounces Troy (508,952 pounds)

Near the large general model there has been installed a small model on a scale of six feet to the inch showing the usual methods of extracting the ore by "stoping." Drilling, picking, timbering, filling old cavities, transporting, raising ore to the surface and other operations are illustrated as well as is practicable on the scale adopted. The shaft is equipped with its cages, which are arranged so that they go up and down by means of automatic machinery.

Specimens of ore, minerals and rocks from the mine and the adjacent country illustrate the geology of the region. Chief of these specimens are velvet malachites that were taken from the original "Queen" mine,

A BIT OF WEYER'S CAVE

Part of the section reproduced in the Hall of Geology.

the Open Cut, in the early eighty's and a great block of malachite and azurite weighing about four tons taken from the Mine in 1892 and exhibited in the Arizona mining exhibit at the Columbian Exposition in 1893.

Caves

The northwest corner of the hall contains a display of caves and cave material including a reproduction of part of a beautiful cave that was discovered early in 1910 in mining operations at the Copper Queen mine. The cave was formed by the dissolving action of water traversing joints in limestone, and its walls, roof and bottom were afterward coated with calcite (calc spar) incrustations, stalactites and stalagmites, some of which are dazzling white while others are colored green with copper salts or pink with manganese compounds.

Alongside the Copper Queen cave is a reproduction of a chamber in Weyer's Cave, Virginia. Weyer's Cave is in a region of much heavier rainfall than Bisbee, which is probably the principal factor in producing a greater wealth of regular stalactite and stalagmite growth than adorns the Copper Queen cave, and this exhibit illustrates not only their great variety in form but the reasons for this extraordinary diversity.

Among the cave material shown nearby is a series of tumblers into which water from the stalactites was allowed to drip for stated periods, the thickness of the deposit giving some measures of the length of time necessary for the formation of stalactites and stalagmites.

Chihuahua Cave Material

Particularly attractive are the marvelously beautiful specimens of calcite, aragonite and gypsum from the famous silver-and-lead mines near Santa Eulalia in the vicinity of Chihuahua, Mexico. These specimens are remarkable for the perfection of their crystalline form or the delicacy of their fibrous developments and for their colors.

[*Return to the Hall of Mastodons and Mammoths and turning to the right enter the West Corridor or Gem Hall.*]

CRYSTAL BALL

West Corridor

GEMS AND PRECIOUS STONES

Gems and Precious Stones

The West Corridor contains the Morgan gem collection. This valuable series of gems and precious stones was presented to the Museum by Mr. J. Pierpont Morgan, one of the founders and a trustee of the institution, whose services to the country in the founding and up-building of the Museum are commemorated in a bronze tablet by Miss Longman at the south end of the hall. It comprises a representative assemblage of cut and uncut gems, many of the former of remarkable size and some of great purity of color. The installation aims to bring into juxtaposition the cut

and uncut material, the former is arranged around the latter, in the center of the cases, and the visitor may thus observe the brilliancy of effect produced in the natural mineral by skillful artificial treatment (cutting).

A partial gradation in importance and value is obtained by the arrangement of the gems, beginning with Diamond at the extreme south and passing north, cases by case (through Corundum (*Sapphire*), Beryl (*Emerald*), Topaz, Tourmaline, Chrysolite, Spinel, Zircon (*Hyacinth*), Chrysolite (*Peridot*), Adularia (*Moonstone*), Opal, Amethyst, Kunzite, Amber, Pearls). In one case a varied collection of semi-precious or ornamental stones is shown, many of which are experimental efforts to use mineral material which can never have any very extended use, viz., prehnite, titanite, sphalerite, hematite, cyanite, etc., etc.

Southwest Wing

MINERALS

Next beyond the Gem Hall is the *Southwest Wing* or Hall of Minerals. At the entrance to the hall is the case in which recent acquisitions are placed. The general collection of minerals consists chiefly of the well-known Bement Collection which contains specimens representing species of the known minerals of the world. Not only is the collection noted for its numbers, but in many instances the beauty and size of the individual specimens are quite unsurpassed in other collections.

Bement Collection of Minerals

Many attractive specimens are displayed in cases arranged down the center of the room. The remainder of the collection is arranged according the classification of minerals. In the first cases on the right or left are models of the six systems of crystals and other introductory illustrations of the physical and optical properties of minerals. Each mineral has a characteristic form of crystallization which is one of the means of identifying it. The distribution of the more important minerals is indicated on maps.

Southwest Pavilion

COLLECTIONS FROM THE PACIFIC ISLANDS

On entering the Southwest Pavilion beyond the Hall of Minerals the visitor faces groups representing the natives of the Pacific Islands. Directly in front is a Tahitian priest taking part in the fire-walking ceremony, in which the participants walk over heated boulders of lava.

On either side are groups engaged in grating cocoanut, making kava, and weaving mats for a house.

In the entrance aisle is a Hawaiian feather cape, such as were worn by the kings and chiefs of Hawaii, especially in war. This specimen has been in America more than a century. The red and yellow feathers are taken from two species of honey suckers. The work required in obtaining the feathers and making the cape is very great.

The hall as a whole falls into two main divisions. On the east are the Polynesian and Micronesians who inhabit Samoa, Hawaii, Tahiti, Marquesas, the Gilbert, Marshall, and Caroline Islands.* Their

HAWAIIAN FEATHER CLOAK

weapons, mats, tapa cloth and the implements used in its manufacture are of especial interest. There are a number of models of canoes to remind us that these people are wonderful boatmen and adventurous seafarers. On the west side are the Melanesians of the Bismarck archipelago, the Solomons, New Hebrides, and New Caledonia. Especial attention is directed to their carvings in wood shown in the large case of sacred masks, and the poles on the case which resemble the totem poles of the northwest coast of America.

Near the entrance to the tower on the left are cases devoted to the

*The Fijians, while Melanesian in race, have a culture very similar to that of Samoa and are therefore represented in the same section of the hall.

natives of Australia, in which are their boomerangs, crude stone tools, and interesting ceremonial objects.

In front of the tower a Maori warrior is balanced on a large boulder of jade in an attitude of defiance. In nearby cases are shown a series of dried, tattooed heads of native inhabitants of New Zealand grewsome relics of the time when Maori warriors preserved the heads of their vanquished enemies. There are also specimens of carving in wood and stone, and a model of a carved storage house.

In the northwest corner of the main hall are several cases devoted to New Guinea. The more prominent objects are nets, stone adzes, carving, and painted tablets and shields. Resting on the case by the doorway are two carved ancestral figures of considerable interest.

The hall due north beyond the Hall of the Pacific Islands is devoted to a collection from the Philippine Islands. Occupying the middle of the hall is the model of a woman weaving a garment on a native loom; next is the model of a small house with walls of bamboo and roof of thatch and beyond the house is to be seen a sailing canoe, outrigged to prevent capsizing. The use of bamboo in place of rope in the rigging of this canoe is of special interest. At the very end of the hall is a native house perched in the top of a tree.

TAHITIAN FIRE WALKER

In the cases on the west side of the hall are arranged collections relating to the Bagobo of Mindanao Island. In the several cases are to be found collections showing the native work in metals, the garments of native fibre decorated with beads, and a very interesting and quite complete exhibition of textiles.

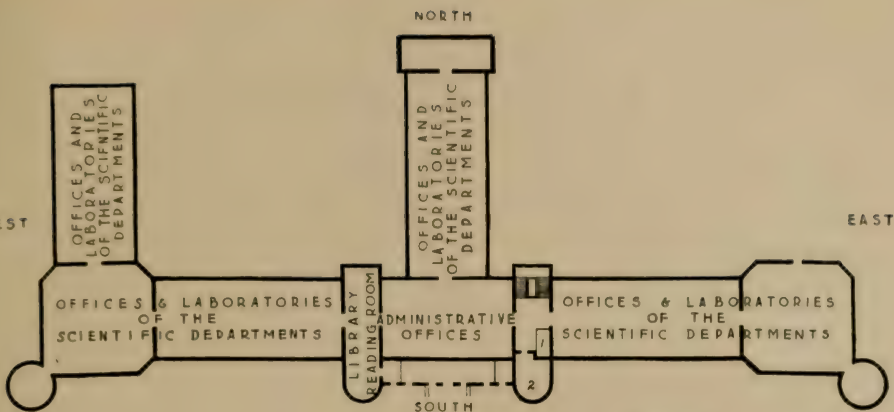
MAORI WARRIOR IN ATTITUDE OF DEFIANCE

At the farther end of the hall are two cases given over to the representative peoples of the islands of Sumatra, Celebes, and Java.

The Samal and Sulu Moros representing the Mohammedan population are next in order. Their war-like character is indicated by the predominance of spears, krises, and shields. There are also some examples of their work in pottery and basketry.

The Igorots of the Island of Luzon have examples of their metal work, weapons and shields, basketry and textiles displayed in cases midway of the hall on the east side.

The Negritos are of special interest because of their small size. They are pygmies and are believed to be descended from the first inhabitants of the island. In the case devoted to them are to be seen an interesting array of diminutive poisoned arrows and the accompanying bamboo quivers. Owing to the increase of the Museum collections and the fact that no addition has been made to the building for the past ten years it may be necessary to rearrange the Philippine exhibits to provide room for the display of African material.



1. Elevators
2. Office of the Director

FIFTH FLOOR

The fifth floor is given over to the administrative offices, the offices and laboratories of the scientific departments and the library which contains some 70,000 volumes on natural history, anthropology and travel.

The library now contains over 15,000 volumes on zoölogy, comprising many of the extremely rare and interesting monographs in ornithology; an excellent collection of 3,500 volumes in entomology, including many of the rare classics, and a 2,000 volume collection in conchology containing the standard works of Kuster, Reeve and Binney. There is also a well selected collection of 2,500 volumes in anthropology, including many of the older works relating to the North American Indian; an excellent collection of 3,500 volumes in geology enriched by the library of the late Professor Jules Marcou; a collection of 5,000 volumes in palæontology, to a large extent composed of the Osborn Library of Vertebrate Palæontology; also an unusually complete collection of more than 25,000 volumes of natural science periodicals.

The reading room of the library is located in the west corridor and, with the exception of Sundays and holidays, is open free daily, from 9 A. M. to 5 P. M., to all who may wish to consult the books. Besides the current issues of the more important periodicals, it contains the more general works of reference, while other volumes will, upon application to the librarian, be furnished to those who wish to consult them.

On this floor, too, are the workrooms of the Department of Vertebrate Palæontology, where the skeletons of fossil animals are prepared and mounted, and the laboratory where are made the beautiful models of invertebrates.

These, like the other laboratories, are of necessity not open to the public.

THE HISTORY AND WORK OF THE MUSEUM

THE American Museum of Natural History was founded and incorporated in 1869 for the purpose of establishing a Museum and Library of Natural History; of encouraging and developing the study of Natural Science; of advancing the general knowledge of kindred subjects, and to that end, of furnishing popular instruction.

History

For eight years its temporary home was in the Arsenal in Central Park during which time many important collections were secured.

The cornerstone of the present building in Manhattan Square was laid in 1874 by President U. S. Grant, in 1877 the first section (South Central Pavilion) was completed, and on December 22, 1877, the Museum was formally opened by President R. B. Hayes.

The Museum building is one of the largest municipal structures in the City, and has cost approximately $5,000,000. The South Façade is 710 feet in length; the total area of the floor space is 470,789 square feet, or about 10 acres, of which 271,886 square feet are open to the public. The building when completed is designed to occupy all of Manhattan Square.

Administration and Support

The building is erected and largely maintained by the City, through the Department of Parks. Building funds are provided for by issues of Corporate Stock, which have been made at intervals since 1871. The annual appropriation, known as the Maintenance Fund, is devoted to the heating, lighting, repair and supervision of the building and care of the collections.

The Museum is under the control of a self-perpetuating Board of Trustees, which has the entire direction of all its activities as well as the guardianship of all the collections and exhibits. The Trustees give their services without remuneration.

The funds which enable the Trustees to purchase specimens, to carry on explorations and various forms of scientific work, to prepare and publish scientific papers and to enlarge the library are raised by contributions from the Trustees and other friends. These contributions come from three sources—namely, (1) the Endowment Fund, (2) Membership Fund, (3) voluntary subscriptions.

The interest of the Endowment Fund, which includes the magnificent bequest of Mrs. Jesup, may be used for additions to the collections, research, and for publication. It cannot be used for the care or repair of the building, construction of cases or other maintenance work, that is properly the province of the City to provide for.

The Membership Fund, derived from the subscriptions of Members, may be devoted to any purpose and is of particular importance in the educational work of the Museum.

Voluntary contributions may be used for general purposes or for such special object as the donor may designate; some of the most valuable and important collections have been obtained by such gifts, as for example the Morgan collection of gems and the Juillard collection of ancient Peruvian pottery and textiles.

Membership

There are at present about 3,700 members. Annual Members contribute $10 a year for the support of the Museum; Life Members make a single contribution of $100. Membership fees are of great service in promoting the growth of the institution.

Definition of a Museum

In the last edition of the Century Dictionary a museum is defined as: "A collection of natural objects, or of those made or used by man, placed where they may be seen, preserved and studied. Neither the objects themselves nor the place where they are shown constitutes a museum; this results from the combination of objects, place and purpose, display being an essential feature. The objects, or specimens, may be shown for general purposes only, or for the illustration of some subject or idea, the tendency of modern museums, being by the display of objects and the manner in which they are arranged and labeled to illustrate some fact in nature or in the history of mankind."

And E. Ray Lankester as Director of the British Museum of Natural History stated that:

Purposes of Museums

"The purposes of a great national museum of natural history are: (1) To procure by its own explorers or by the voluntary assistance of independent naturalists the actual specimens upon which accurate knowledge of the animals, plants, and minerals of the earth's surface, and more especially of the national territory, is based; to preserve and arrange these collections for study by all expert naturalists, and to facilitate, directly or indirectly, the publication (in the form of catalogues or monographs) of the knowledge so obtained—with a view to its utilization, not only in the progress of science, but in the service of the State. (2) To exhibit in the best possible way for the edification of the public, at whose charges these collections are made and maintained, such specimens as are fitted for exposure in public galleries, with a view to the intelligent and willing participation of the people in the maintenance of the Museum."

As the Museum is emphatically "for the people," special attention is given to making the exhibits attractive and interesting as well as instructive.

BLIND CHILDREN "WITH PEARY AT THE NORTH POLE"

While the American Museum of Natural History cannot claim to have originated the idea of displaying animals amid their natural surroundings, it was the first large museum in this country to adopt this method which it has since carried out on a large scale in (see *Reprint* "The Story of Museum Groups") the well-known habitat groups. How it has been developed the visitor may judge by comparing the group of Robins with the great Florida Group and the Hopi Group.

In the Museum were also developed the methods of preparing and mounting the skeletons of extinct animals that have resulted in such mounts as *Brontosaurus* and *Tyrannosaurus*, and the series showing the development of the horse, so that they might be something more than an assemblage of uninteresting bones.

How These Purposes Are Carried Out

Lectures

The Museum not only maintains exhibits "for the edification of the public," but supplements the educational work performed by these and their accompanying labels by lectures and publications of a popular nature. A course of evening lectures is given every Spring and Fall for the Members, to which admission is to be had by ticket; also courses of Science Stories are given on Saturday mornings for the children of members. Another series of lectures, free to the public, is given in conjunction with the Board of Education on Tuesday and Saturday evenings. Still another series, under the direction of the Museum's Department of Public Education, is given for the children in the Public Schools, and there are special lectures for the blind provided for by the Thorne Memorial Fund. The educational work of the Museum is carried still farther by means of its circulating collections for illustrating nature study which are sent free to the schools of Greater New York. The extent to which these collections are used is shown by the following statistics for the last five years:

	1912	1913	1914	1915	1916*
Number of Collections in use	537	597	675	671	704
Number of Schools of Greater New York Supplied	491	501	470	473	439
Number of Pupils Studying the Collections	1,275,890	1,378,599	1,273,853	1,238,581	1,118,322

*The year of the infantile paralysis epidemic when school work and visits of scholars were greatly curtailed.

HOW SPECIMENS ARE CARED FOR

One of the fireproof storerooms of the Department of Anthropology.

In 1916 the work of the Museum was extended by the establishment of local lecture centers, or courses of lectures given by members of the Museum staff in certain of the public schools.

Arrangements were also made by which the large series of lantern slides, numbering more than 25,000, were loaned to teachers for use in class rooms.

The scientific side of the work of the Museum is based upon its explorations and study collections.

Study Collections

The Study Collections, as the name implies, are not only for the benefit of students but preserve a record of our vanishing animal life and of the life and customs of our own and other primitive peoples.

In the case of Natural History the vast majority of the specimens are in the study series, not only because they would ultimately be ruined by exposure to light but because the display of all material would only confuse the visitor. Moreover, no museum has room to show everything, and a careful selection is made of objects of the greatest educational value and these are so displayed as to enhance their interest and attractiveness.

The Study Collections are, briefly, as follows:

Anthropology—Ethnology.—On the attic floor of the west wing and the northwest pavilion there are thirty-three fireproof storerooms containing the ethnological study collections of more than 100,000 catalogue numbers, comprising extensive series for the Philippine Islands, Siberia, China, Africa, South Africa and the various culture areas in North America.

The human skeleton material is chiefly from western States and South America. About two thousand crania have been classified and made available for study.

Archæology.—In archæology there is a large type series of stone objects from the various States of the Union. Full collections from excavated sites in British Columbia, Washington State, New York State, Kentucky, Arizona and New Mexico are here, together with a special series from the Trenton Valley. There is much material from Mexico, Peru and Bolivia.

Geology.—The study collections comprise, among other things, the Hitchcock series of rocks illustrating thirteen geological sections across the States of Vermont and New Hampshire; a complete set of duplicate specimens from the United States geological survey of the Fortieth Parallel; a series illustrating the early geological survey of Pennsylvania; a complete typical series of rocks and microscopic thin sections illustrating Rosenbusch's manual of petrography; large series of American

rocks; a complete series typifying the rocks encountered in driving the Simplon tunnel, Switzerland; many ores and economic specimens.

Invertebrate Palæontology.—Great numbers of fossil invertebrates, too numerous and varied to particularize, but representing many of the important groups and including a large number of types.

Foremost among these is the James Hall collection comprising about 7,000 types of New York State fossils, though most important additions have been made, especially during 1917.

Ichthyology.—The collection of fishes comprises about 7,000 catalogued specimens, preserved in alcohol and kept in tanks and jars.

The fossil fish collection is one of the largest, if not the largest, in America, comprising about 10,000 catalogued specimens; it includes the Newberry, the Cope and several smaller collections.

Herpetology.—The collection of frogs, salamanders and reptiles numbers about 15,000 specimens.

Invertebrate Zoölogy—General Invertebrates.—About 60,000 specimens of protozoans, sponges, polyps, starfishes, sea-urchins, worms, crustaceans, spiders, myriapods and chordates.

Insects.—(*a*) Local collection comprising insects within fifty miles of New York City. (*b*) General collection including more than 500,000 specimens, among them the types of many species.

Shells.—The Molluscan collections of the Museum, exclusive of fossils, include about 15,000 species, comprised for the most part of the Jay and Haines collections.

Mammalogy.—The study collection of mammals contains about 35,000 skins, skulls and skeletons exclusive of the material obtained by the Congo Expedition which has not yet been fully catalogued, but comprises about 5,800 mammals, 6,200 birds, 4,800 reptiles and 6,000 fishes, besides 3,800 ethnographical specimens and more than 100,000 invertebrates, the results of six years' work.

The Museum is especially rich in South American forms. Mexico and the Arctic are well represented; from the latter region there is a large and unique series of the beautiful white Peary's caribou and of the Greenland muskox, comprising about 150 specimens. The collection of whales is one of the finest in the world.

Ornithology.—The study collection of birds consists of approximately 130,000 skins and mounted birds, about nine-tenths of which are from the Western Hemisphere, and several thousand nests and eggs. South America is represented by a large collection from Matto Grosso, Brazil, and very extensive collections from Colombia, Ecuador, Peru, Venezuela and Trinidad.

From North America, there are important collections from Mexico, Nicaragua, California, Texas, Arizona and the Middle Atlantic States—the Rocky Mountain region being most poorly represented. Of special collections, the George N. Lawrence and Maximilian collections are of special importance from the hundreds of type specimens which they contain.

Mineralogy.—Most of the mineral specimen are on exhibition, but the overflow from the public cases forms a study series of no mean proportion.

Public Health.—Living bacteria are maintained and distributed free to recognized laboratories.

Vertebrate Palæontology.—The study collections comprise about 15,000 catalogued specimens of fossil mammals, 6,000 fossil reptiles and amphibians and a few hundred fossil birds. Most of these are from the western United States. The collections of fossil horses, Eocene mammals and Cretaceous dinosaurs are unrivaled. The fossil rhinoceroses, camels, oreodonts, carnivora, Fayum, Pampean and Patagonian mammals, Jurassic dinosaurs, Permian reptiles, turtles, etc., are likewise of the first rank. They include more than nine hundred type specimens of fossil mammals and several hundred type specimens of fossil reptiles and amphibians.

Library

The Museum Library, located on the fifth floor, contains about 70,000 volumes on various branches of natural history (save botany,) anthropology and travel. It is particularly strong in vertebrate palæontology and scientific periodicals. Like other museum libraries, it is of necessity a reference librrry, but, except on Sundays and holidays, may be freely used by the public during the hour when the Museum is open.

The Osborn Library, founded by President Osborn, is also on the fifth floor and contains works on vertebrate palæontology and related subjects.

Publications

The publications of the Museum, aside from the *Annual Report*, fall naturally into two groups: scientific and popular. The former, comprising the *Memoirs*, *Anthropological Papers* and *Bulletin*, contain information gathered by the various expeditions, or derived from the study of material collected; they are from the nature of their subjects mainly of a technical character. The *Memoirs* consist of the larger, more important papers, or those that call for unusually large illustrations. These are issued from time to time as occasion may demand. The *Bulletin* comprises the shorter papers, those that contain information that it is desirable to issue promptly, and a volume of about 400 pages is issued annually. The scientific papers are distributed,

largely in exchange, to museums and libraries throughout the world.

The popular publications include the *Journal, Leaflets, Guides* and *Handbooks,* and are intended for the information of the general public. The *Journal,* begun in 1900, is the means of promptly informing the Museum members of the work of the institution, giving the results of the many expeditions, telling of the collections made, or more important informations gathered. It also describes at length interesting or noteworthy installations, and notes the accessions to the various departments, changes in the personnel of the Museum, and elections to Membership. The *Illustrated Guide Leaflets* deal with exhibits of particular interest or importance, such as the Habitat Group of Birds, the Evolution of the Horse, Meteorites, the Indians of Manhattan, calling attention to important objects on exhibition and giving information in regard to them. The *Handbooks,* five of which have been issued, deal with subjects or topics rather than objects. Thus the Plains Indians Handbook, by Dr. Wissler, is not merely a guide to the exhibition hall, but tells of the life and customs of these Indians, their language, political organization, religious beliefs and ceremonies.

The distribution of these popular publications is a part of the educational work of the Museum, as are exhibits and lectures, and so far they have been necessarily sold below the cost of publication, as is done by other Museums. (*See list at end of this Guide.*)

Workshops

An important part of the Museum, not seen by the public, is the workshops, located in the basement and provided with machinery of the most improved pattern. Here, among other things, are constructed the various types of cases used in the Museum, including the light, metal-frame case, devised in the institution.

Still other rooms, which, of necessity, are not open to the public, are the laboratories, wherein is carried on the varied work of preparing exhibits, work which calls for the services of a very considerable number of artists and artisans.

Here are cast, modeled, or mounted the figures for the many groups from Man to Myxine, here leaves are made to grow and flowers to bloom as accessories for beasts,* birds and fishes, to say nothing of reptiles and amphibians, and here, with painstaking care, are slowly created in glass and wax the magnified copies of invertebrates.

From all this may be gathered that a museum is a very busy place, much more so than the casual visitor is apt to imagine. In fact, a very good museum man has said that a museum is much like an iceberg, seven-eighths of it under water and invisible.

*See *Guide Leaflet* No. 34.

MEMBERSHIP

For the purchase or collection of specimens and their preparation, for research, publication, and additions to the library, the Museum is dependent on its endowment fund and its friends. The latter contribute either by direct subscriptions or through the fund derived from the dues of Members, and this Membership Fund is of particular importance from the fact that it may be devoted to such purposes as the Trustees may deem most important. There are now more than four thousand Members of the Museum who are contributing to this work. *If you believe that the Museum is doing a useful service to science and to education, the Trustees invite you to lend your support by becoming a Member.*

The various Classes of Resident Membership are as follows:

Annual Member	(annually)	$10
Sustaining Member	(annually)	25
Life Member		100
Fellow		500
Patron		1,000
Associate Benefactor		10,000
Associate Founder		25,000
Benefactor		50,000

They have the following privileges:

An Annual Pass admitting to the Members' Room.
Complimentary tickets to the Members' Room for their friends.
Services of the Instructor for guidance through the Museum.
Two course tickets to Spring and Autumn Lectures.
Current numbers of all Guide Leaflets on request.
Complimentary copies of the American Museum Journal.

ASSOCIATE MEMBERSHIP

In order that those not living in New York City may be associated with the Museum and its work, the class of Associate Members was established in 1916. These Members have the following privileges:

Current issues of the American Museum Journal—*see page 136.*

The President's Annual Report, giving a full list of Members.

An Annual Pass admitting to the Members' Room. This large room on the third floor is given over exclusively to Members, and is equipped with every comfort for rest, reading and correspondence.

Two complimentary tickets admitting to the Members' Room for distribution by Members to their friends.

The services of an Instructor for guidance when visiting the Museum.

INDEX

Page numbers of illustrations are set in heavy face type.

PUBLICATIONS OF THE MUSEUM

The Scientific Publications of the Museum comprise the *Memoirs* and *Bulletin* edited by F. E. Lutz and the *Anthropological Papers* edited by Clark Wissler. These publications cover the field and laboratory researches of the institution.

The Popular Publications of the Museum comprise the *Handbooks, Leaflets,* and *General Guide,* edited by Frederic A. Lucas, and the *Journal,* edited by Mary Cynthia Dickerson.

NOTE: The prices given are net, postage extra.

HANDBOOKS

These deal with subjects illustrated by the collections rather than with the objects themselves.

NORTH AMERICAN INDIANS OF THE PLAINS

By CLARK WISSLER, PH.D., Curator of Anthropology. October, 1912, 145 pages, maps and illustrations.

Paper, 25 cents; Cloth, 50 cents

INDIANS OF THE SOUTHWEST

By PLINY EARLE GODDARD, PH.D., Curator of Ethnology. March, 1913, 190 pages, maps and illustrations.

Paper, 25 cents; cloth, 50 cents

ANCIENT CIVILIZATIONS OF MEXICO AND CENTRAL AMERICA

By HERBERT J. SPINDEN, PH.D., Assistant Curator, Department of Anthropology. 238 pages, 81 illustrations.

Cloth, 75 cents

ANIMALS OF THE PAST

A popular account of some of the Creatures of the Ancient World. By FREDERIC A. LUCAS, SC.D., Director of the Museum. 250 pages with 41 illustrations by Charles R. Knight and Joseph Gleeson.

Paper, 35 cents

DINOSAURS, with special reference to the American Museum Collections.

By W. D. MATTHEW, PH.D., Curator of Vertebrate Palæontology. December, 1915, 162 pages, 48 illustrations. Paper, 25 cents

ILLUSTRATED GUIDE LEAFLETS

These describe some exhibit, or series of exhibits, of special interest or importance, or may deal with the contents of an entire hall; some of the earlier leaflets are out of print.

THE COLLECTION OF MINERALS

By LOUIS P. GRATACAP, A.M., Price, 5 cents

The minerals have been moved since this leaflet was issued, but it contains much information about the collection and a number of figures of interesting specimens.

NORTH AMERICAN RUMINANTS

By J. A. Allen, Ph.D., February, 1904. Price, 10 cents

Describes the rapidly disappearing large game of North America, such as the Bison, Elk and Mountain Sheep.

THE HABITAT GROUPS OF NORTH AMERICAN BIRDS

By Frank M. Chapman, Sc.D. Price, 25 cents

Second edition issued May, 1916. 64 pages, 35 illustrations

THE INDIANS OF MANHATTAN ISLAND AND VICINITY

By Alanson Skinner Price, 20 cents

New edition, 54 pages, many illustrations.

PLANT FORMS IN WAX

By E. C. B. Fassett Price, 10 cents

THE EVOLUTION OF THE HORSE

By W. D. Matthew, Ph.D. Price, 20 cents

63 pages, 39 illustrations.

MAMMOTHS AND MASTODONS

By W. D. Matthew, Ph.D. Price, 10 cents

26 pages, 12 illustrations.

HOW TO COLLECT AND PRESERVE INSECTS

By Frank E. Lutz, Ph.D. Price, 10 cents

21 pages, illustrated.

OUR COMMON BUTTERFLIES

By Frank E. Lutz, Ph.D., and F. E. Watson Price, 15 cents

Describes and figures natural size 31 species of the eastern states.

THE BIG TREE AND ITS STORY

23 pages, 9 illustrations. Price, 10 cents

PERUVIAN ART

By Charles W. Mead Price, 10 cents

Figures and describes the designs used on ancient Inca pottery and textiles. 10 pages, 6 full page illustrations.

SOUVENIR STAMP ALBUM

A series of 100 subjects printed from four color plates, each stamp 2⅛ x 3 inches. Sold in sets of 15 stamps for 10 cents. Album providing space for the entire series including 10 stamps, 15 cents. Album and complete series of 6 sets of stamps, 75 cents; postage, 4 cents.

GUIDE TO THE NATURE TREASURES OF NEW YORK CITY

Price, 75 cents

The purpose of this illustrated guide is to render accessible under one cover an account of the public scientific institutions of Manhattan, the Bronx, and Brooklyn.

These publications may be purchased in the Visitors' Room near the entrance, from the Attendants or from the Librarian.

THE AMERICAN MUSEUM JOURNAL

The American Museum Journal is a magazine issued primarily to keep members in touch with the activities of the Museum as depicted by pen and camera; also to furnish Members with reliable information of the most recent developments in the field of natural science. It takes the reader into every part of the world with great explorers; it contains authoritative and popular articles by men who are actually doing the work of exploration and research, and articles of current interest by men who are distinguished among scientists of the day. It takes the reader behind the scenes in the Museum to see sculptors and preparators modeling some jungle beast or creating a panorama of animal life. It shows how the results of these discoveries and labors are presented to the million public school children through the Museum Extension System. Published monthly from October to May. Terms one dollar and a half per year.

FREE TO MEMBERS OF THE MUSEUM

SOME REPRINTS
OF IMPORTANT ARTICLES IN THE JOURNAL

THE GROUND SLOTH GROUP
By W. D. Matthew, Ph.D. — Price, 5 cents

THE WHARF PILE GROUP
By Roy W. Miner, A.B. — Price, 5 cents

THE SEA WORM GROUP
By Roy W. Miner, A.B. — Price, 10 cents

THE ANCESTRY OF THE EDENTATES
By W. D. Matthew, Ph.D. — Price, 5 cents

HEREDITY AND SEX
By Frank E. Lutz, Ph.D. — Price, 10 cents

THE STORY OF MUSEUM GROUPS
By Frederic A. Lucas, Sc.D. — Price, 10 cents

THE NEW AFRICAN HALL
By Carl E. Akeley — Price, 5 cents

AMERICAN MUSEUM OF NATURAL HISTORY

FOR THE PEOPLE

FOR EDUCATION

FOR SCIENCE

AMERICAN MUSEUM OF NATURAL HISTORY

INSECTS AND DISEASE

BY

C.-E. A. WINSLOW

AND

FRANK E. LUTZ

GUIDE LEAFLET No. 48

MODEL OF MALARIAL MOSQUITO

INSECTS AND DISEASE

A Statement of the More Important
Facts with Special Reference to
Everyday Experience

BY
C.-E. A. WINSLOW AND FRANK E. LUTZ

American Museum of Natural History
GUIDE LEAFLET No. 48
NEW YORK, JUNE, 1918
PRINTED AT THE MUSEUM

"I deal with certain little Invertebrata; animals which work in darkness and in stealth, little animals which in times of Peace we politely ignore, yet little animals which in times of War may make or unmake an army corps. As that wise old Greek, Aristotle, wrote—and he knew quite a lot about them—'One should not be childishly contemptuous of the study of the most insignificant animal. For there is something marvellous in all natural objects.'"

A. E. Shipley, "*Minor Horrors of War.*"

INSECTS AND DISEASE

By C.-E. A. Winslow
and F. E. Lutz

THE IMPORTANCE OF INSECTS

The life of man is affected, for good or ill, at a thousand points by the activities of the humbler members of the living world of which he forms a part. The lower animals and plants supply us with our food and clothing and with materials for providing shelter against the elements. On the other hand, certain species are our relentless foes, waging constant war against our property and even our lives.

In the case of the insects, for example, as we review the multitudes of these creatures within our limited horizon, we not only admire the wondrous beauty of this species or the amazing instincts of that; we are awestruck at the financial havoc wrought by one and appreciate with gratitude the way in which another helps to restore the balance of Nature and protect us from starvation. Even among the microbic forms of life, in the world of the "infinitely little," we find, on the one hand, the bacteria of the soil fixing the nitrogen of the air and making it available for our growing crops — on the other, the bacilli of tuberculosis and of a score of other deadly diseases, threatening the health and life of hundreds of thousands.

One of the most interesting and important chapters in the story of the interrelationships between mankind and the lower forms of life is that which deals with the triple relation between the microbe, the insect and the human being in the spread of certain communicable diseases. The types of insects and their relatives concerned are, on the whole, more disgusting than beautiful; their habits are not attractive, nor are their instincts extraordinary; but they have profoundly influenced the history of the human race. You and I may lose our lives by reason of their activities; we certainly can aid in combating them. It, therefore, behooves us to become well acquainted with our foes.

CHARACTERISTICS OF INSECTS

First of all, a word should be said as to the characteristics of these creatures and their place in Nature. Those animals which have no internal skeleton but do have, at some period of their lives, jointed legs are called Arthropods. Familiar examples are lobsters, spiders, centipedes, and insects. We are now chiefly concerned with certain insects but we must also consider mites and ticks, creatures which are more closely related to the spiders. An insect has its body divided into three regions: head, thorax, and abdomen. Its jointed legs are borne by the thorax, the segments of the body which are just back of, but separated from, the head; there are never more than three pairs of such legs in an adult insect. Spiders, mites, and ticks have, typically, four pairs of jointed legs, and the head is merged with that part of the body which bears the legs.

The great majority of insects are winged, when adult, and most winged insects have two pairs of wings, but the members of the large Order Diptera, to which mosquitoes and flies belong, have never more than one pair. Nearly all of the strictly parasitic insects are wingless, even when adult. We will take up first those disease-bearing insects which have, when adult, one pair of wings, next certain wingless insects, and finally the mites and ticks.

Two sorts of Diptera or two-winged insects are of interest in the present connection: (1) ordinary "flies" with three-jointed antennæ; and (2) mosquitoes, gnats, etc., which have eight or more freely moving joints in each antenna. The Muscidæ and the Tabanidæ (p. 13) are of the first sort.

The Muscidæ, a group which includes our commonest disease-bearing insect, the filth fly, are characterized as follows:

The squamæ (see Fig. 1) of Diptera are scale-like structures placed back of the roots of the wings and above the knobbed "balancers"; and the Muscidæ agree with the related Diptera in having these squamæ large. The auxiliary vein in the wing (see Fig. 1) is distinct in its whole course, and the first longitudinal vein is never very short. The thorax has a complete transverse suture. The eyes of the male are usually much nearer together than those of the female; sometimes, in fact, so close that they touch each other.

Fig. 1. THE FILTH FLY (*Musca domestica*)

a. Auxiliary vein
b. First longitudinal vein
c. Fourth longitudinal vein
d. Discal cell
e. Anal cell
f. Antennæ
g. Transverse suture
h. Squama
i. Abdomen
j. Tibia

THE FILTH FLY

Musca domestica

More volumes have been written about this insect in the last twenty years than have been devoted to any other one insect (unless it be the honey-bee) since man became civilized enough to write about insects at all.

This fly is commonly called the "house fly," but that name has been justly criticized because it seems to imply a necessary domestic relation. We do not believe that this insect should be a *house* fly in the future; and Dr. L. O. Howard of Washington, in view of its relation to disease, has suggested that is should be called the Typhoid Fly. This seems, on the other hand, to relate rather too closely a disease and an insect which are sometimes, but not universally, connected. Filth Fly is perhaps the best term and one that is undoubtedly applicable. The fly breeds in filth, it resorts to filth, and it carries filth with it everywhere it goes.

The excellent figures given here, combined with common experience, are sufficient for the identification of the "ordinary house fly," or "typhoid fly," or "filth fly." Note (Figs. 1 and 4) especially the rounded angle in the fourth longitudinal vein, the plumose antennal bristle, the absence of stout bristles on the abdomen, the absence of a vertical row of bristles between the base of the hind legs and the "balancers," and the absence of a prominent bristle near the middle of either middle tibia. As is the case with many other Diptera, the males of this species have the eyes closer together than do the females. The sides of the abdomen in the male are brownish near the base and grayish elsewhere. The females are grayish over the whole abdomen with a variable pattern of darker gray or black.

The filth fly, like all other Diptera, passes through four definite stages in its life cycle: egg, larva, pupa, and adult. The eggs of the fly (one or two hundred in number) are laid by preference in horse manure but may also be deposited in almost any moist decaying organic matter, such as "human excrement, pig manure, decaying grain, moist bran, moist mixtures of hay and grain from feed troughs of animals, excreta-soiled straw, contents from slaughtered animals, decaying kitchen refuse, rotting fruits and vegetables, excreta-soiled paper and rags, and ensilage." Dr. Howard estimates that probably 90% of our filth flies are hatched from horse manure. Only certain portions of a manure pile are, however, favorable for fly breeding, "a layer some inches deep and lying a few inches below the surface where there may be found a moderate amount of heat and moisture, an excess of either being fatal or compelling migration."

It takes the eggs of the fly about twelve hours, on the average, to hatch. The larvæ are whitish creatures, blunt at the posterior end and pointed in front. They have no bristles or hairs. On the blunt end are spiracles or breathing holes. In young larvæ these spiracles are in a heart-shaped aperture; later they appear in two slits; and still later in three winding slits. The changes occur when the larvæ cast their skins at intervals during their growth while feeding on the manure or other material in which they live.

About five days after hatching, the maggot, now about half an inch long, burrows downward into the ground or outward into the drier portions of the manure and there changes to a brownish pupa about ¼ inch long. The pupal stage may last from three or four days to several weeks, and recent observations suggest that autumn broods usually pass the winter in this form, although the fly may

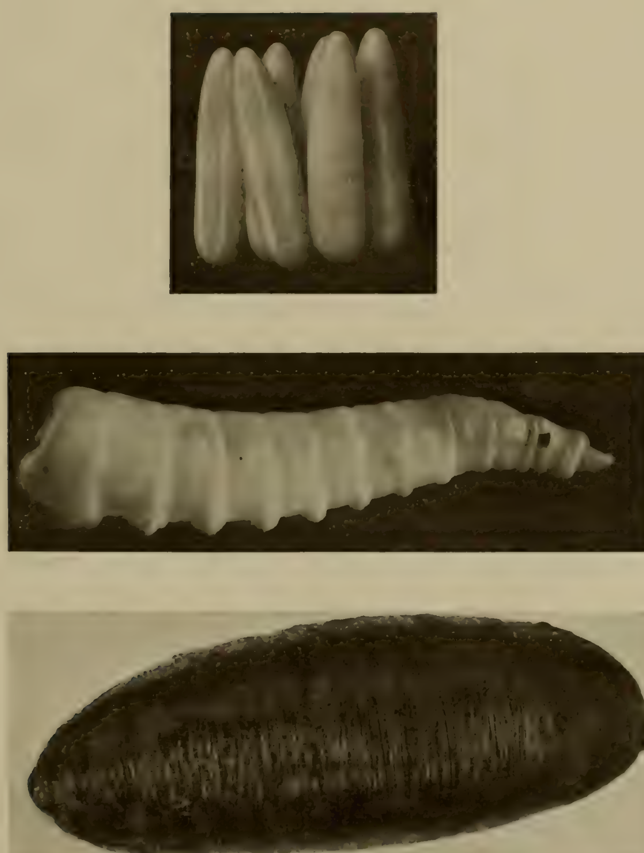


Fig. 2. EGGS, LARVA AND PUPA OF THE FILTH FLY
(Photograph of models in The American Museum of Natural History)

hibernate in any stage. At the termination of the pupal stage the fly comes out of the pupal case and crawls up to the surface of the material in which it pupated. Here its wings quickly harden and it is ready to fly away.

The rate at which generations of flies follow each other is determined by the temperature. Studies made in the Laboratory of Public Health of the American Museum gave a total period from egg laying to the emergence of the adult of 9.3 days at 35° C., 10.3 days at 30° C., and 22.3 days at 20° C.

The adult fly lives upon liquid food, since its mouth parts are in the form of a sucking proboscis, but by discharging a free flow of saliva it is able to turn foods like sugar into the fluid form it can absorb.

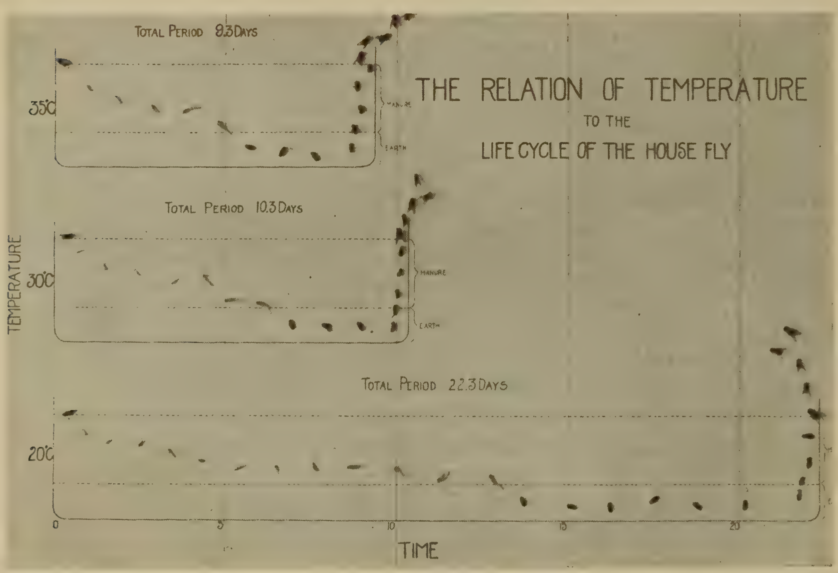


Fig. 3

Fig. 4. THE FILTH FLY (*Musca domestica*)
(Photograph of model in The American Museum of Natural History)

RELATIVES OF THE FILTH FLY

There are a number of other flies sometimes found in houses which may be mistaken for the Filth Fly, and the characteristics of a few of them may be briefly described.

Homalomyia canicularis is often supposed to be a "young house fly." It does look like a small edition of the more common and dangerous insect; but it is a wholly different species. No insect grows after it has attained to the dignity of wings. The wing-veins of *Homalomyia* run without a sharp bend to the margin of the wing. This creature is really not even a muscid; it belongs to the Anthomyidæ. It breeds in waste organic matter such as manure.

Fig. 5. THE LITTLE HOUSE FLY
(*Homalomyia canicularis*)

Muscina is a muscid genus. Our species may be recognized by the fact that they are black flies and not shining; the median stripe on the thorax is light, the fourth longitudinal vein is only slightly bent and the first posterior cell is scarcely contracted at the margin; the hind end of the thorax may be reddish. *M. stabulans* has the legs and palpi more or less yellowish, while those of *M. assimilis* are wholly black. The larvæ feed on excrement and a variety of decaying substances including fungi and vegetables.

Pollenia rudis is known as the "cluster fly" from the habit which the adults have of congregating in masses, especially about the ceilings of rooms, when they are looking for a place in which to hibernate. When mashed, these flies are very greasy and have an odor which has been described by some as like honey and by others as "very disagreeable." They breed, as parasites, in earthworms. The thorax has no distinct stripes and is usually covered with a yellowish "dust"; the space between the eyes is white, the fourth longitudinal vein is sharply bent.

The genus *Lucilia* includes the "green- and blue-bottle flies." Both the thorax and abdomen are bright and metallic. This description would apply also to certain other Muscidæ, but it has not been

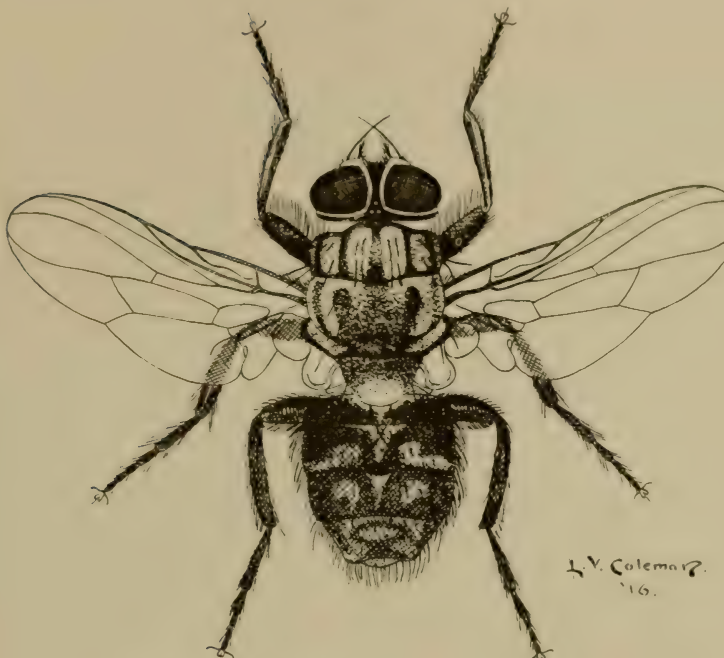


Fig. 6. THE STABLE FLY (*Muscina stabulans*)

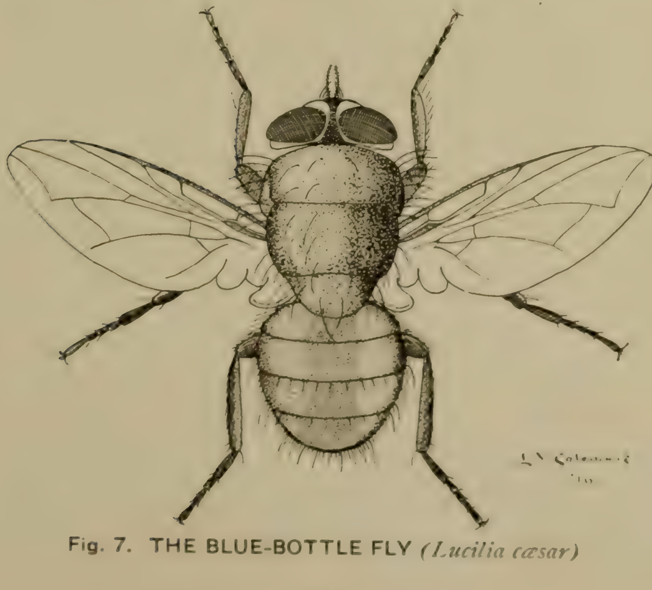


Fig. 7. THE BLUE-BOTTLE FLY (*Lucilia cæsar*)

shown that the "bottles" are instrumental in transmitting diseases and a further diagnosis would require going into details which would be out of place here. The larvæ feed chiefly on carrion but those of *L. cæsar* occur also in garbage and excrement.

These notes on various Muscidæ (in a broad sense) and an Anthomyid have been given for the purpose of introducing the table given below.[1] It will be seen from this table that the only fly which is very abundant on human excrement and also in dining rooms is *Musca domestica.* This is the principal reason why this fly is so dangerous.

Flies found in Dining Rooms

Flies found on Human Excrement	Very Abundant	Abundant	Moderately Abundant	Rare
Very Abundant	*Musca domestica*			*Borborus equinus*
Abundant			*Muscina stabulans*	*Sarcophaga sarraceniæ* *Ophyra leucostoma* *Pseudopyrelia cornicina* *Myospila meditabunda*
Moderately Abundant		*Homalomyia canicularis*	*Lucilia cæsar*	
Rare			*Drosophila ampelophila* *Stomoxys calcitrans*	*Pollenia rudis* *Calliphora erythrocephala*

[1]Reprint from the *Field Book of Insects* (G. P. Putnam's Sons), by Frank E. Lutz. It may not be out of place to say that this book gives further details, which cannot be included here, concerning the identification and habits of other insects which are troublesome but not actually dangerous.

BITING FLIES

Stomoxys calcitrans. If ordinary house flies seem to be adding to their other vices by biting, it is a case of mistaken identification; the culprits are almost certainly the *Stomoxys calcitrans*, the "biting stable fly." Its proboscis is long, slender, and pointed, not fleshy and blunt as is that of *Musca domestica* (page 5). The name, stable fly, is not very appropriate, as this fly is neither the most abundant fly about stables, as a rule, nor does it breed chiefly about stables unless a quantity of wet, fermenting hay or straw be present. Piles of lawn-cuttings or of weeds furnish more *Stomoxys* than do ordinary stables. Adults are more frequently found about buildings in damp weather and just before a storm than at other times, for which reason the saying has arisen that the biting of flies is a sign of a storm. The best method of control is self-evident—do away with the breeding places either by destroying the material, covering it so that flies do not have access to it, or drying it so that the larvæ cannot live.

Fig. 8. THE BITING STABLE FLY (*Stomoxys calcitrans*)

The most conspicuous biting flies in the Northeastern United States belong to the Tabanidæ and are variously called "horse flies," "gad flies," and "green-headed flies." The head is large; each antenna has three joints, the last being somewhat subdivided into from four

to eight parts; the eyes are large and usually brightly colored when the insect is alive; the proboscis is sometimes as long as, or longer than, the body; the thorax and abdomen bear hairs but not bristles; each wing has two submarginal and five posterior cells; the anal cell is usually closed but not far before the border of the wing; the marginal vein runs entirely around the wing. The larvæ are aquatic, or semi-aquatic, and predacious. They taper at both ends and each of the eleven segments into which the body is divided bears a circlet of small spines. The adults fly by day, usually being found in warm sunny places, though some prefer shady woods. Only the females bite; both sexes feed on the juices of plants and on similar substances. There are several hundred species recorded from North America.

The only other biting Calypterate which we have in the Northeast is *Hæmatobia serrata*, the "Horn fly." It is less than half the size of *Stomoxys calcitrans* and the palpi are nearly as long as the proboscis, while in *Stomoxys* they are much shorter than the proboscis.

The genus *Glossina* includes the tsetse flies; it is found only in Africa at the present time, although it formerly occurred in America, as is proved by fossils unearthed in Colorado. The tsetse flies are as large as, or larger than, *Musca domestica*, the ordinary house fly; the waist is constricted; the wings are crossed when at rest; the fourth longitudinal vein bends before it meets the very oblique anterior transverse vein. Both sexes bite, usually by day, but also at night if the moon be bright. The larvæ almost complete their development within the body of their mother and are then laid at the roots of plants. The pupal stage lasts from six to eight weeks. Several species have been described and their habits carefully studied but, owing to the facts that the larvæ are carried by the female until nearly or quite full-grown and that the adults feed on the blood of other animals than man, control methods are difficult.

Certain insects are not real transmitters of disease but are themselves its inciting agents. There are, for instance, dipterous larvæ, "maggots," which occur by accident or as a part of their normal life-history in the human body. Such an occurrence is called myiasis. The most important species in this connection is the "screw-worm," *Chrysomyia macellaria*. It is a blow fly which has been classed with the Muscidæ and also with the Sarcophagidæ. The adult fly is nearly, or quite, half an inch long; metallic green; with three longi-

tudinal dark stripes on the thorax; its head is reddish to yellowish brown; its wing venation is similar to that of *Musca domestica*. Several hundred eggs (sometimes the eggs hatch before they are laid and then living larvæ are deposited) are placed on carrion or in wounds or sores in living animals. In the case of man, the eggs are usually laid in the nostrils of those suffering from nasal catarrh. The yellowish-white larva has rings of bristle-like structures on the segments, which give it the appearance of a screw. If it is not removed from the nostril, it may work in, causing an abscess and even death. Blow flies of the genus *Calliphora* (Muscidæ with metallic colored abdomen but dull colored thorax; fourth longitudinal vein sharply bent; distal third of antennal bristle bearing some hairs; cheeks unicolorous) sometimes lay their eggs on cold meat, especially pork, and the larvæ are then taken into the stomachs of careless eaters. Usually not much harm is done. The same is true of *Lucilia* (see page 10). The Œstridæ are closely related to the Muscidæ but the adults have rudimentary mouth-parts. They are the bot flies, and certain species do great damage to stock. In tropical America human beings are parasitized by the Œstrid *Dermatobia hominis*, and possibly other species. The larvæ live underneath the skin of various parts of the body. William B. Herms, in his useful *Medical and Veterinary Entomology* (Macmillan Medical Co., New York), gives a key to the larvæ ordinarily involved in myiasis.

THE FILTH FLY AND DISEASE

Musca domestica is not only a pest but a serious menace to health on account of the likelihood that it may carry filth from the unsavory places which it frequents to food. The foot of the fly is tipped with claws and soft pads on which there is ample room for great numbers of microbes to be transplanted; and, as a matter of fact, if a fly be allowed to walk over the surface of a properly prepared bacterial culture plate, the path over which it travels is marked by numerous

Fig. 9

colonies of bacteria, each developed from a single germ planted there by the foot of the insect. Even more serious, perhaps, is the danger that disease germs ingested by a fly from privy contents, or other infected material, may be voided in its excrement (fly specks) or in small droplets which are regurgitated by the insect. Experiments have shown that many kinds of disease germs may pass through the intestines of the fly and be discharged in its excrement in an active and virulent state.

The spoiling of foods may obviously be hastened by ordinary putrefactive germs introduced in such ways and, if the fly has been feeding upon human discharges (tuberculous sputum for example, or the contents of an outside closet used by an incipient typhoid case) specific human diseases may easily result.

Fig. 10. BACTERIAL COLONIES DEVELOPED ON AN AGAR PLATE FROM GERMS PLANTED BY THE FEET OF A FLY WHICH WALKED OVER IT

The number of microbes actually carried by flies varies greatly with the general amount of filth in their surroundings. Studies made by the New York Association for Improving the Condition of the Poor gave an average of 13,986 bacteria per fly (on the outer surfaces of its body) in clean localities, against 1,106,017 in dirty surroundings. The germs of typhoid fever and Asiatic cholera have been isolated from the bodies of flies caught during epidemics of these diseases, and we have, in our museum of living bacteria at the American Museum, one strain of typhoid bacilli isolated in this way in the course of an outbreak in New Jersey.

It was the experience of the American troops in the Spanish War which first forcibly called attention in this country to the danger of the transmission of disease by flies. About one out of five of our volunteer soldiers contracted typhoid during the campaign, and the investigators who studied the cause of this disastrous affair concluded that "the number of cases of typhoid fever in the different camps varied with the methods of disposing of the excretions." The typhoid germs, in most cases, were probably spread from person to person by more or less direct contact, but the fly undoubtedly played its part. Doctors Reed, Vaughan and Shakespeare pointed out in their official report that "flies swarm over infected fecal matter in the pits and then deposit it and feed upon the food prepared for the soldiers at the mess tents. In some instances, where lime had recently been sprinkled over the contents of the pits, flies with their feet whitened by lime were seen walking over the food."

The investigators also point out that, "Officers whose mess tents were protected by means of screens suffered proportionately less from typhoid fever than did those whose tents were not so protected," and again that "Typhoid fever gradually disappeared in the fall of 1898 with the approach of cold weather and the consequent disabling of the flies."

In the World War flies have constituted a grave menace to the health of troops operating in tropical and semitropical regions. On the western front they have been remarkably well controlled by burning manure and garbage and by protecting latrines. At Gallipoli and in Egypt, however, they have been responsible for the spread of dysentery and many other parasitic diseases among the French and English troops.

The most striking evidence in regard to the importance of the fly as a carrier of disease is, perhaps, that furnished by the experience of Jacksonville, Fla. Ever since the encampment of troops at Jacksonville in 1898 the city has been heavily infected with typhoid fever. No reliable data are available before 1908, but the typhoid death rates per 100,000 population for the years 1908, 1909, and 1910 were 82, 75 and 106 respectively. In the late summer of 1910 a law was passed requiring that all dry closets within the city should be rendered fly-proof. By March, 1911, about 75 per cent. of the closets had been brought into conformity with the law and the typhoid rate for the year dropped to 63. By January, 1912, practically all the closets had been rendered fly-proof and the typhoid rate dropped to 26.

The danger of transmission of disease by flies increases with the extent to which human excreta are exposed to the access of flies and with the duration of the warm season, which favors fly breeding. Danger is not confined, however, to unsewered rural districts or to the South. The Association for Improving the Condition of the Poor in New York City made a careful study of the relation between flies and infant diarrhea in the summer of 1914. Nearly 1000 infants were carefully observed, half of them being in ordinary homes and half in homes where special efforts were made to protect the infant and his food from flies. The homes studied were classified according to their general cleanliness and according to their freedom from flies. In the homes where flies were abundant, 1.9 times as many infants suffered from summer diarrhea as in the homes protected from flies, and 1.8 times as many were attacked under dirty conditions as in the clean homes. Where both factors were combined, in dirty and fly-ridden homes, there were 2.4 times as many infants who suffered from diarrhea as in the clean and fly-protected tenements.

PREVENTION OF FLY-BORNE DISEASE

The practical methods of controlling the spread of disease by flies fall under four main headings: the prevention of fly breeding, the destruction of adult flies, the protection of human discharges from access of flies, and the protection of food by screening houses and covering the food itself.

PREVENTION OF FLY BREEDING

The usual methods employed in fighting the dangerous Muscidæ are really of little avail. Sticky fly-paper, wire flytraps, and poisons will undoubtedly kill a large number but infinitely more are breeding where they came from. Screening our windows and doors will undoubtedly keep many out but it is not pleasant to live in a cage. Furthermore, the people from whom we buy our milk and other food-stuffs may not be so careful. The only thoroughgoing method is to stop the trouble at its source—prevent fly breeding. The adults we kill cannot thereafter breed, but they have probably done so before and many of their companions are sure to escape altogether. If we could do away with the breeding places, or make them unfit for fly larvæ, or keep adult flies away from them, the thing would be done. Nearly all the books and lecturers say that this is easy. It is well to be optimistic but better to recognize the whole truth. It cannot be done easily.

If anti-fly campaigns are to be successful your neighbor must keep his place clean too, for his flies are just as apt to come into your house as his, so the problem becomes one for the whole community. This is the heart of the matter. A few earnest individuals or well-meaning Improvement Societies, by themselves, can do little more than cause a great deal of trouble and very little good. Laws must be made and enforced so that the ignorant or careless may not make of little or no avail the work of the intelligent and careful.

Since 90 flies out of every 100 are probably born in a manure pile, the elimination of the natural breeding places of the fly means, first and foremost, the proper care of stable manure. Stables should not have dirt floors, since it has been shown that the ground moistened by animal discharges contains many larvæ and pupæ. Floors should be water-tight, preferably of cement, and constructed so as to drain freely into a sewer or covered cement pit. In wooden floored stables flies should be excluded from the ground beneath the floor boards. Openings left for ventilation should be screened with wire and no holes should be bored in the floor for drainage of urine.

Fig. 11. MODEL SHOWING A GOOD TYPE OF MANURE BIN
(American Museum of Natural History)
The surface of the manure is being sprinkled with a chemical to prevent fly breeding.

It has generally been recommended that the manure itself should be kept in a dark vault or pit from which flies are shut out by screens, or in a tight covered box. The health officer of Asheville, N. C., where an unusually successful anti-fly campaign has been carried out, believes that screening of manure has been over-emphasized and that tightly floored boxes and thorough and complete cleaning up of these floors at frequent intervals are the main desiderata. He points out that most manure already contains fly maggots when placed in the bin and that an elaborately screened bin is hard to clean so thoroughly that development may not take place in the manure left behind.

A method of storing manure which is specially applicable to military camps depends on the fact that flies cannot breed readily in this material when it is closely packed. A rectangular area of ground is staked off and the manure is built up into compact heaps, the sides being kept straight and beaten hard with shovels. The adjacent ground is also beaten hard and loose straw is placed in small windrows about a foot from the edge. The absence of air in the interior of the heap, with the high temperature and chemical products due to bacterial fermentation, makes the manure highly unfavorable for fly development, and any larvæ which succeed in developing in the surface layer will pass out and pupate in the ring of straw, which should be swept up every two or three days and burned.

The United States Bureau of Entomology has devoted special attention to the problem of chemical treatment of manure for the purpose of poisoning the maggots which might otherwise be bred therein. Any one who is interested in the control of this insect pest should write to the Bureau of Entomology, Washington, D. C., and to the Department of Agriculture of his own State, for the latest recommendations in regard to this method of treatment, which is constantly being improved and made more economical and efficient. The following suggestions are taken from Farmers' Bulletin 851 of the United States Department of Agriculture and represent the best procedures available in 1917.

For manure or other refuse not to be used as a fertilizer, powdered borax is the best chemical preventive of fly breeding; .62 pound per 8 bushels of manure, or about 1 pound per 16 cubic feet, will destroy 90 per cent. of the larvæ present. The borax should be applied in solution, or water should be sprinkled on after scattering dry borax evenly over the pile.

Borax-treated manure in large amounts may injure crops; and, for manure which is to be used on the land, powdered hellebore may be recommended. A water extract is prepared by adding ½ pound of powder to every 10 gallons of water, stirring and allowing to stand for 24 hours. The stock mixture thus prepared is sprinkled over the manure at the rate of 10 gallons to every 8 bushels (10 cubic feet) of manure. Hellebore, while more expensive than borax, in no way injures the manure.

A third alternative has been suggested by the Department of Agriculture, which, while showing a still higher first cost, involves the use of substances which serve directly to increase the fertilization value. A mixture of ½ pound of calcium cyanamid plus ½ pound of acid phosphate to each bushel of manure killed 98 per cent. of the larvæ when scattered evenly over the surface and wetted with water, at the same time adding to the manure the valuable elements nitrogen and phosphorus.

"It is well to bear in mind that the house flies breed in many substances other than horse manure, for example, in pig manure, chicken manure, ensilage, moist bran, rotting potatoes, and in decaying matter on the public dumps of towns and cities, and it is necessary to give attention to all such accumulations where active fermentation is taking place."

A highly ingenious method of preventing breeding of flies in manure is the maggot trap devised by Dr. E. C. Levy, Health Officer of Richmond, Va. Its use is described by Mr. Hutchinson of the United States Bureau of Entomology as follows:

"The maggots of the house fly, when they have finished breeding, show a distinct tendency to migrate and will crawl away from the manure, especially if it is moist, in search of a comparatively dry and safe place to pass the pupal or resting stage. Now, if the manure is placed on a slatted platform, and if the platform stands on the floor of a concrete basin containing ½ inch or more of water, the larvæ in migrating will drop into the water and be drowned. Each day the stable cleanings should be placed on the platform and compactly heaped and well moistened. For the purpose of keeping the manure wet, it is best to have a small cistern close to the platform and a pump so placed that the watering of the manure heap is easily accomplished. If the liquid manure from the stables is conducted by drains to the cistern, the valuable plant food which it contains will thus be added to the manure on the maggot trap. Experiments have

Fig. 12. TRAP FOR THE DESTRUCTION OF FLY LARVÆ
(Maggot Trap)

shown that the maggot trap will destroy 99 per cent. of the maggots developing in manure. After the manure has been standing on the maggot trap for 10 days it will be practically free from maggots and may be used on fields or gardens or stored in heaps without likelihood of any further breeding taking place in it. The advantages of the maggot trap are that it is cheap, requires little extra labor to operate and to dispose of the drowned maggots, and it does not lessen the value of the manure but rather tends to preserve it. As is the case with all other methods, the use of the maggot trap must be supplemented by careful attention to possible breeding places other than horse manure."

2. Destruction of Adult Flies

Simple and effective flytraps may be used to some advantage in decreasing the number of flies. Their use has been advocated not only because of their immediate results, but because of the chance that the flies may be caught before they lay their first batch of eggs, and that thus the possible number of future generations will be materially reduced.

Many types of flytraps are on the market, and as a rule the larger ones are the more effective. Anyone with a few tools, however, can construct flytraps for a small part of the price of the ready-made ones. A trap which is very effective in catching flies, and is easily made, durable, and cheap, may be constructed as follows:

"The trap consists essentially of a screen cylinder with a frame made of barrel hoops, in the bottom of which is inserted a screen cone. The height of the cylinder is 24 inches, the diameter 18 inches, and the cone is 22 inches high and 18 inches in diameter at the base. Material necessary for this trap consists of four new or second-hand barrel hoops; one barrel head; four laths; 10 feet of strips 1 to 1½ inches wide by ½ inch thick (portions of old boxes will suffice); 61 linear inches of 12- or 14-mesh galvanized screening 24 inches wide for the sides of the trap, and 41 inches of screening 26 inches wide for the cone and door; an ounce of carpet tacks, and two turn buttons, which may be made of wood." The cost of the material for this trap is not great, and in many cases the barrel hoops, barrel head, laths and strips can be obtained without expense.

"In constructing the trap, two of the hoops are bent in a circle (18 inches in diameter on the inside) and nailed together, the ends being trimmed to give a close fit. These form the bottom of the frame

(A), and the other two, prepared in a similar way, the top (B). The top (C) of the trap is made of an ordinary barrel head with the bevel edge sawed off sufficiently to cause the head to fit closely in the hoops and allow secure nailing. A square, 10 inches on the side,

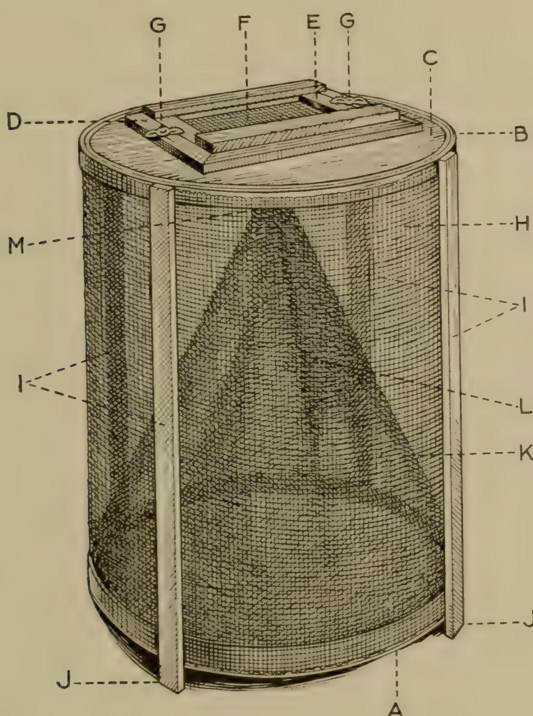


Fig. 13. A SIMPLE FLYTRAP (see text)

is cut out of the center of the top to form a door. The portions of the top (barrel head) are held together by inch strips (D) placed around the opening one-half inch from the edge to form a jamb for the door. The door consists of a narrow frame (E) covered with screen (F) well fitted to the trap and held in place (not hinged) by buttons (G). The top is then nailed in the upper hoops and the sides (H) formed by closely tacking screen wire on the outside of the hoops. Four laths (I) (or light strips) are nailed to the hoops on the outside of the trap to act as supports between the hoops, and the ends are allowed to project 1 inch at the bottom to form legs (J).

The cone (K) is cut from the screen and either sewed with fine wire or soldered where the edges meet at (L). The apex of the cone is then cut off to give an aperture (M) 1 inch in diameter. It is then inserted in the trap and closely tacked to the hoop around the base."

The effectiveness of the traps will depend on the selection of a good bait. For attracting house flies beer is probably the best. It loses much of its attractiveness after the first stages of fermentation are over, and for this reason it should be renewed every day or two. Milk is also a good bait. Over-ripe or fermenting bananas, crushed and placed in the bait pans, give good results. A combination of bananas and milk is more attractive than either used separately. A mixture of 3 parts water and 1 part cheap molasses is very attractive after it has been allowed to ferment for a day or two. A mixture of equal parts of brown sugar and cheese (or curd of sour milk), thoroughly moistened, give good results after it has been allowed to stand for three or four days. For catching blow flies and other meat-infesting flies, the best bait is the mucous membrane from the lining of the intestines of hogs. Ordinary fish or meat scraps may be used.

Fly paper is sometimes helpful, particularly the long slender roll of sticky paper hung from a ceiling. For a fly poison, Professor Phelps of the United States Public Health Service recommends either formaldehyde or sodium salicylate, three teaspoonfuls of the 40 per cent. commercial solution of formaldehyde, or the same amount of powdered sodium salicylate to a pint of water. Nearly fill a glass tumbler with the solution, place over this a piece of blotting paper cut to circular form and somewhat larger in diameter than the tumbler, and over this invert a saucer. Invert the whole device. The blotting paper will remain in the proper moist condition until the entire contents of the tumbler have been used and the strength of the formaldehyde solution will be maintained. A little sugar sprinkled upon the paper will increase the attractiveness of the poison for the flies. Either of these preparations may be safely used where there are young children, although the addition of the sugar is not recommended in such cases.

The killing of flies in the house by "swatters" is also of some value, although where the insects are abundant the majority of them should be eliminated by the more efficient methods of trapping.

Among natural enemies which help to destroy flies in either the larval or the adult state are hens, swallows, phœbes and other birds, and toads.

3. Protection of Human Discharges from Access of Flies

The measures suggested above will greatly reduce the numbers of flies but, as a rule, will not do away with them entirely. It is, therefore, always essential to take precautions against the spread of specific human diseases by guarding intestinal discharges from the access of flies. Outside closets, where they cannot be replaced by a cesspool or sewer system, should always be carefully constructed so as to exclude insects, all openings for ventilation screened, and cracks in walls or openings below the floor level tightly closed. In the army, the construction of fly-proof latrines is a first essential of camp sanitation.

4. Exclusion of Flies from Houses and from Access to Food.

Finally, flies should be excluded from dwellings by careful screening of doors and windows. Screens must be always in place and must fit tightly. In particular, the kitchen and the dining room should be protected in this way.

The covering of foods in stores and restaurants is one of the most important aspects of the campaign for clean and pure foods, and it is wise to avoid all such places where flies are abundant and food unprotected.

THE MOSQUITOES AND THEIR ALLIES

The blood-sucking habit, and the modifications of mouth-parts necessary to such a habit, are to be found in several, not closely related, groups of the two-winged insects, Diptera. All blood-suckers are to be looked on with suspicion, because of the possibility that they may be the intermediate hosts of disease-parasites. Several such insects have already been mentioned; but another group of quite different creatures remains to be discussed.

If a moquito, crane fly, or some similar insect, be carefully examined, it will be seen that the antennæ ("feelers") consist of not less than eight joints, rather similar one to another; the antennæ are usually longer than the thorax (the middle part of the body, the part which bears the wings and legs); the anal cell (see Fig. 14) is rarely narrowed in the border of the wing and the discal cell is usually absent. These are distinguishing characteristics of the nematocerous Diptera or Orthorrhapha, that group of Diptera to which mosquitoes, punkies, black flies, and blood-sucking gnats in general belong.

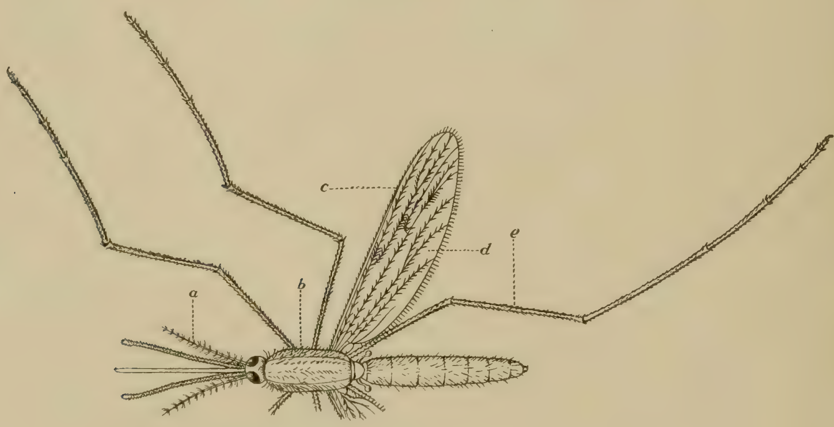


Fig. 14. STRUCTURAL CHARACTERS OF THE MOSQUITO

a. Antenna *b.* Thorax
c. Costal vein of wing *d.* Anal cell
e. Tibia

Of the Nematocera, there are four families (Culicidæ, Psychodidæ, Simuliidæ, and Ceratopogonidæ) which contain blood-sucking species. The adults of the first two of these, Culicidæ and Psychodidæ, unite in typically having the following characteristics: at least nine

veins extend to the margin of each wing; the top of the thorax does not have a distinct V-shaped suture near the middle; the costa (Fig. 14) continues around the hind margin of the wing; and the wing veins bear conspicuous, scale-like hairs. The Culicidæ (Mosquitoes) are slender; they have long, slender, usually moderately hairy or scaly legs; their tibiæ (the second large joint of the legs) have apical spurs; the wings are elongate and narrow. The Psychodidæ (Moth-flies) are small and robust; their legs are short and densely hairy; the tibiæ have no apical spurs; the wings are short, broad, and sometimes pointed apically. The Simuliidæ and Ceratopogonidæ have more than four distinct longitudinal veins but less than nine veins extend to the margin of each wing, and the wings do not have a network of fine creases; the costal vein does not continue beyond the apex of the wing; and there are no ocelli (small, simple eyes which, when present, are situated between, often above, the conspicuous compound eyes). The Simuliidæ (Black-flies, etc.) are usually very small and thick-set; the antennæ are shorter than the thorax; each antenna is composed of ten or eleven closely united segments, not plumose; the hind pair of legs are more or less dilated; the anterior veins of the wings are stout, the posterior ones weak. The Ceratopogonidæ (Punkies), like the Chironomidæ with which they were formerly united but from which they have been separated because of their piercing mouth-parts, are slender delicate gnats; the antennæ are slender, the joints more or less constricted and sometimes plumose; the femora of the slender legs are sometimes thickened.

General notions are not always safe guides in the classification of insects. However, our general notions as to what a mosquito is, combined with the discussion in the preceding paragraph, will probably suffice to enable us to recognize a culicid. No male of any species of Culicidæ ever "bites." The females of most of the species with which we come in contact have the ability and desire to pierce the human skin with their needle-like mouths, if they get a chance, and to suck a small drop of blood. If this were all they did, it would be bad enough, but, when they pierce the skin, they inject an irritating substance, saliva, which sometimes "carries with it the microscopic, unicellular animals which cause malaria, and down this minute, microscopic [salivary] duct has flowed the fluid which has altered the fate of continents and played a conspicuous part in the destruction of the ancient civilizations of Greece and Rome" (Shipley).

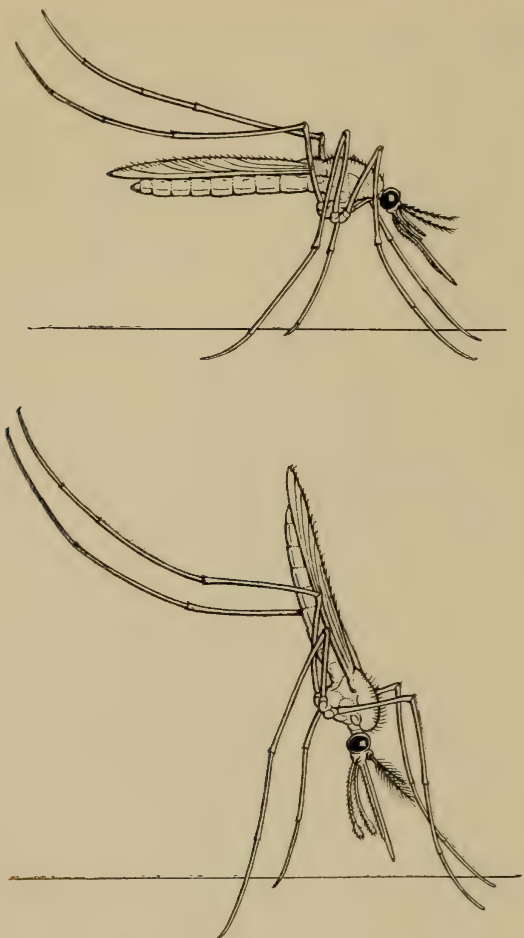


Fig. 15. RESTING POSTURE OF CULEX (above) AND ANOPHELES (below)

The disease-bearing and rest-disturbing habits of mosquitoes have led to a detailed and almost feverish study of their taxonomy. Species have been named and genera erected on the basis of characters which are very difficult for the non-professional to use. Formerly, the common species of true mosquitoes inhabiting the northern part of the United States were divided into two genera: *Anopheles* and *Culex*. As *Anopheles* contains the malarial mosquito

(or mosquitoes) it is the more important in the present connection, although not so numerous in species as the old, inclusive, *Culex*. Not all species of *Anopheles* have spotted wings, and not all spotted winged mosquitoes are *Anopheles*, but, for practical purposes and especially in the northeastern United States, we may say that mosquitoes with spots on their wings are *Anopheles* and that those with plain wings are something else. Furthermore, the adults of *Anopheles* are given to holding their beaks in a line with their bodies while *Culex* points the beak downward at an angle to the body-line. One of the technical points used in identifying adults of *Anopheles* concerns the relative lengths of the palpi and beak. The palpi are delicate, thread-like organs, one on each side of the beak. In the male the palpi are more feathered than in the female; this is even more true of the antennæ, or "feelers." Both sexes of *Anopheles* have the palpi nearly, or quite, as long as the beak; the females, at least, of our other mosquitoes have the palpi relatively short, rarely exceeding half the length of the beak. If one extends the three first fingers, the middle finger may be taken to represent the mosquito's beak and the other two fingers the pair of palpi of *Anopheles*. If, now, the first and ring fingers be bent at the end of the first joint, the three fingers, as viewed from above, may serve as a model of the relative lengths of the palpi and beak of the female *Culex*. In applying this test, be careful not to confuse the antennæ with the palpi.

Fig. 16. RESTING POSTURE OF MOSQUITO LARVÆ; ANOPHELES (left); CULEX (right)

Mosquito larvæ live only in water but the females of certain species display what might almost be called foresight; they lay their eggs on ground which will later become covered with water, as on the mud of low places along a salt-marsh. The most familiar mos-

quito eggs are those of the rain-barrel species—eggs which are laid on end, side by side, in a boat-shaped mass on the surface of the water in barrels, tubs, and similar places. The eggs of *Anopheles* are laid singly but frequently they float close to each other, the floating being favored by special structures along their sides. The larva, or "wriggler" which hatches from an egg of *Anopheles* has a very short breathing siphon on its back at the tail end. The larva is lighter than water; when feeding or at rest, it floats just below the surface and parallel to it; when disturbed it wriggles vigorously from side to side, the motion sometimes carrying it downward but more frequently sideways. When at the surface, the end of the breathing siphon pierces the "surface film," opens up, and exposes the ends of the tracheæ, the tubes which convey air to all parts of the creature's body. In order to feed on the microscopic plants and other organic material floating at the surface, the larva twists its neck until its mouth is on a line with its back. While there are other, more technical characters, it is sufficient to say that a mosquito larva which has a short, stubby breathing siphon, floats parallel with the surface of the water, and twists its head to feed is an *Anopheles*. The *Culex* larva floats at an angle with the surface as shown in Fig. 16, and has a relatively long breathing siphon.

As a young insect feeds, its flesh increases but its skin does not stretch sufficiently to accommodate the enlarging body. Therefore, the old skin is cast from time to time and a new, larger skin is formed. Finally there comes a time, as in the case of such insects as moths and beetles, which like the Diptera have a "complete metamorphosis," when there emerges from a larval skin something which is neither larva nor adult, and which is called the pupa. The pupa of moths is, for the most part, immobile and frequently enclosed in a protective case, the "cocoon," which is spun for it by the larva. The pupa of mosquitoes is active, but not so active as a larva, and it does not feed. It also differs from the larva in being hunched up instead of slender and in having a pair of breathing siphons on its thorax (the part of the body just back of the head) instead of a single siphon on the tail. The pupa of *Anopheles* closely resembles that of *Culex*, but the abdomen is more sharply curved and the breathing siphons are more dilated at the top and relatively shorter than in *Culex*. The adult mosquito finally emerges from a split in the back of the cast pupal skin, which forms a miniature boat upon which the

adult may stand while stretching itself before it flies away to perpetuate its species, perhaps at the expense of ours. Studies on a common fresh-water mosquito (*Culex pipiens*) made at the American Museum showed that at 20° C. the cycle was completed in 19.6 days, at 25° in 11.7 days, and at 30° in 7.8 days.

In the vicinity of New York City there are three fairly common species of *Anopheles: punctipennis, crucians*, and what was formerly called *maculipennis*, more recently *quadrimaculatus*, but which probably should be called *guttulatus*. Remembering Pope's advice concerning the choice between the old and the new, we will use the name *quadrimaculatus*.

Anopheles punctipennis is "a medium sized dark brown mosquito with the upper surface of the thorax dark brown at the sides and with several narrow lines of yellowish gray hairs appearing as one broad gray stripe in the center. The beak and legs are unbanded; the wings densely clothed with black and yellow scales, two large black patches and two smaller ones on the front margin especially conspicuous. The abdomen is dark brown, profusely scattered with yellowish brown hairs" (Smith). The other two species to be mentioned here have no whitish spot on the front margin of the wings.

Anopheles crucians "is brown, not quite as dark as *punctipennis*, with the thorax striped with grayish scales, the wing veins clothed with whitish and black scales, the black ones especially collected along the wing margin" (Smith). The hindmost wing vein has three black spots separated by two yellowish-white ones. This mosquito flies earlier in the evening and later in the morning than either *punctipennis* or *quadrimaculatus*, and has, for this reason, been called the Daylight *Anopheles*.

Anopheles quadrimaculatus may be recognized by the four small dark spots on each of its yellowish wings. It is the species usually thought of in connection with malaria in this country and it has been observed to breed in brackish water as well as fresh.

Little need be said concerning the other mosquitoes of northern regions, in connection with disease. They are troublesome on account of their biting habit, and for the same reason they are to be looked on with suspicion since they may be the unknown carriers of some disease. The females have relatively short palpi and the larvæ relatively long breathing siphons. In the South, however,

there are certain very important species. *Culex quinquefasciatus*, also known as *fatigans*, extends as far north as Washington and St. Louis, its larvæ replacing the northern *pipiens* in the rain-barrels. In both species the eggs are laid in boat-shaped masses floating on the surface of the water. The wings of both species are clear and both species have white cross-bands on the abdomen; these abdominal bands are joined to lateral spots in *pipiens* but separated from the lateral spots in *quinquefasciatus*.

Aëdes calopus, formerly called *Stegomyia fasciata*, the Yellow-fever Mosquito, is frequently carried by vessels into temperate regions but it has not succeeded in establishing itself there. The adult flies by day instead of by night. *Aëdes* is a genus which is separated from *Culex* by characters rather difficult for the layman to make out. Some of our common salt-marsh mosquitoes are now put in this genus. The following list of characters will probably differentiate *calopus* from anything with which it is likely to be confused; the claws on the front and middle feet of the female are toothed; the joints of the black feet are white-ringed, but at the bases only; the beak of the female is not white-ringed; the thorax is not markedly paler than the abdomen and bears silvery-white lines in the pattern of a lyre, but no median white line; the abdomen has distinct, segmental white bands which are continuous across the abdomen; the wing-scales are narrow and mostly brown.

Howard and others, in their report on mosquitoes published by the Carnegie Institution, say concerning *calopus*: "Under natural conditions the eggs are laid singly in small irregular groups some distance above the margin of the water..... The larvæ live in accumulations of water in artificial receptacles. From being originally a tree-hole-inhabiting species, it is now wholly domesticated, and its larva inhabits artificial accumulations of water either within houses or in the vicinity of human habitations. Occasionally the larvæ occur in holes in trees, but always in proximity to habitations. Goeldi has found the larvæ in water held by bromeliads, presumably near houses, and by the still folded leaves of banana plants. In the tropics the earthen jars in which drinking water is kept within dwellings are favorite breeding-places; the larvæ have the habit of keeping to the bottom, and, as these jars are never emptied, their presence is not even suspected. Water may be poured from the small earthen bottles used in hotels in the tropics, and, unless the bottle is quickly and completely emptied, the larvæ will remain

behind. Holy-water founts in churches are a favorite breeding-place. Out of doors the larvæ occur in tanks, barrels, rain-barrels, rain-troughs and discarded bottles and tins. The larvæ, when suspended from the surface film, hang nearly perpendicular. . . . . Unlike many other mosquitoes they (the adult females) emit no sound when about to bite. The male likewise persecutes man and this has led to a widely quoted statement of Ficalbi that it sucks blood; however, it does not pierce the skin but laps sweat from the surface and in this way causes some irritation."

Several other families of nematocerous Diptera should be briefly mentioned on account of their blood-sucking habits.

Psychodidae. Some of the characteristics of this family were given on page 29. The most common—possibly the only—genus found in the vicinity of New York City is *Psychoda*. Its larvæ live in decaying vegetable matter, exuding sap, cow dung, and other moist excrementitious matter. The small, moth-like adults run well but fly weakly. They feed largely on nectar and rarely, if ever, "bite" animals, although they may sip fluids from wounds. In the tropics there is a genus, *Phlebotomus*, in which the species have the proboscis rather elongated and these do pierce the skin of man and other animals for the purpose of sucking blood. Some of these species are believed to be instrumental in the transmission of disease.

Simuliidae. See page 29 for some of the characteristics of the family. The species have received various common names including "buffalo gnats," "black-flies," "sand-flies" and "turkey gnats." The principal genus is *Simulium* and, although there are not many species, individuals sometimes occur in countless hordes. The larvæ live in running water, usually where the current is swiftest. There the larvæ sit on their tails catching for food the organic matter which the stream floats to them. They are often so numerous that the object on which they are gathered seems to be covered with moss. Unfortunately, the bite of the adult is not in proportion to its small size and when hundreds of bites are received in one day it is easy to believe the reports of deaths of both cattle and human beings from the bites alone. In addition to this, they have been suggested as possible carriers of anthrax to cattle and of pellagra to man.

The Ceratopogonidæ were mentioned on page 29 because of their biting habits; they have not, as yet, been connected with any disease. The species of *Culicoides* are the blood-sucking "punkies" or "no-see-ums." The larvæ are aquatic.

MOSQUITOES AND MALARIA

Few diseases have, until recent times, seemed more mysterious than malaria. This malady was defined in Quain's Standard Dictionary of Medicine as late as 1894 as "an earth-born poison, generated in soils, the energies of which are not expended in the growth and sustenance of healthy cultivated vegetation. By almost universal consent this poison is the cause of all the types of intermittent and remittent fevers, commonly called malarial, and of the degeneration of the blood and tissues resulting from long residence in places where this poison is generated."

"Malaria," the Encyclopedia continues, "has generally been said to be the product of heat, moisture and vegetable decomposition. The terms marsh miasm, and paludal fevers, long employed to distinguish the poison and the fevers to which it gives rise, mark the almost universal belief that the air of marshes alone is endowed with the power of generating them. That low, moist, and warm localities are generally noted as malarious, is indisputable. Marshes are not, as a rule, dangerous when abundantly covered with water; it is when the water level is lowered, and the saturated soil is exposed to the drying influence of a high temperature and the direct rays of the sun, that this poison is evolved in abundance. The production of malaria on a great scale in this way was seen in the district of Burdwan, in Bengal. The soil is alluvial, but dry; and until within the last few years, Burdwan was more salubrius than the central or eastern districts of the lower Gangetic delta. The drainage of the district became obstructed by the silting up of its natural and artificial outlets, the result being a water-logged condition of the soil, the development of malaria, and an alarming increase in the death-rate.

"Malaria is, however, generated under conditions apparently widely different from the above. When the British Army under Wellington was operating in Estremadura, the country was so arid and dry for want of rain, that the rivers and small streams were reduced to mere lines of widely detached pools; yet it was assailed by a remittent fever of such a destructive malignity that, says Ferguson, who records the fact, 'the enemy and all Europe believed that the British host was extirpated.'"

Again "The disturbance of soil that has long been fallow is often followed, both in hot and temperate climates, by the evolution of malaria. A familiar example was the prevalence of intermittent fever in Paris during the fortifications of the same city, in the reign of Louis Philippe, and on a larger scale in different parts of France when the railways were in process of construction."

It had been noted that "malaria is freely generated at the bases of mountain ranges in tropical climates," that "temperature exercises great influence over its development and activity," "many places can be visited with impunity in winter which are dangerous in summer and autumn"; that "malaria drifts along plains to a considerable distance from its source, when aided by winds sufficiently strong to propel, but not to dispel it"; that "under the influence of currents of heated air it can ascend, in dangerous concentration, far above its source"; that "a belt of forest interposed between any malarial place and human habitations affords considerable protection."

Could anything be more mysterious than this picture? Yet only three years after this article appeared in Quain's Encyclopedia the mystery was solved.

The germ of malaria, a Protozoan parasite which destroys the red cells of the blood, had been first seen by a French surgeon, Laveran, in 1880, and an individual observer here and there had suggested a possible connection between malaria and mosquitoes. In 1883 an American, A. F. A. King, had urged with special force the hypothesis that "the mosquito is the real source of the disease rather than the inhalation or cutaneous absorption of a marsh vapor."

It was only in the early nineties, however, that the proof of this assumption was at last furnished. Patrick Manson and Ronald Ross, two English physicians, at that time began serious work on the mosquito theory and in 1897 Ross discovered the germ of bird malaria in the stomach of the mosquito. The Italians, Grassi and Bignami, first demonstrated the germ of human malaria in the body of the mosquito in 1898 and in 1900 Sambon and Low showed that it was possible to remain immune from disease in the most malarious region of the Roman Campagna if protected against mosquitoes while Dr. Manson's son and another volunteer were inoculated with malaria in England by the bites of infected mosquitoes shipped alive from Italy.

The malaria germ is an example of a parasite which requires two different hosts in which to complete its life history. Asexual cycles are completed in the blood of man at regular intervals of 48 or 72 hours, the recurrent period of chill and fever corresponding to the time at which new generations are set free in the blood stream. The complete development of the parasite, however, must be accomplished in the stomach of a mosquito belonging to the genus *Anopheles*.

When one of these mosquitoes sucks the blood of a malaria patient it draws in the germ which passes through its sexual stage in the body of the mosquito; and after a period of ten or twelve days a new generation of germs find their way into the salivary glands of the mosquito, where they lie ready to infect any new victim who may be bitten by the insect.

The control of mosquito breeding, then, at last offered definite hope of checking this disease which had laid so heavy a burden upon many populous countries and some of the most fertile regions of the earth.

Celli estimated that malaria caused two million cases of disease and 15,000 deaths a year in Italy. We have no adequate statistics of its ravages in the southern United States, although the importance of the problem has recently been forcibly set forth in an admirable monograph by Mr. F. L. Hoffman.

A careful study made in Alabama in 1911 revealed 70,000 cases and 770 deaths in that one state and that one year. Certain counties in southern Missouri have experienced death rates from malaria of over 100, and in one instance nearly 300 per 100,000 population. Howard estimates the money loss due to this disease in the United States at $100,000,000 a year.

During the past summer (1917) malaria was the second largest cause of sickness among our American troops in mobilization camps.

CONTROL OF MOSQUITO-BORNE DISEASE

The control of mosquito-borne disease involves five principal measures: (1) the elimination of mosquito-breeding places, (2) the destruction of mosquito larvæ in accumulations of water which can-

Fig. 17. MOSQUITO-BREEDING NEW JERSEY MARSHLAND BEFORE DRAINAGE

Fig. 18. SAME AREA SHOWN IN Fig. 17 AFTER DRAINAGE

not be removed, (3) the destruction of adults, (4) the protection of human beings from access of mosquitoes, and (5) immunization and treatment by the use of quinine.

Those who would control injurious insects should use a combination of common sense and knowledge of the insects' habits. It should not be necessary to mention the second factor, for common sense would point out the necessity of such knowledge, except that so many otherwise sensible people pick up a smattering of entomology and straightway feel competent to handle the complicated problems presented in nature. No important piece of work should be undertaken without expert help. On the other hand, mere knowledge of the insect's habits is not sufficient, as has been shown by some utterly impractical methods of control which have been suggested. The notes which have been given here on the habits of mosquitoes are the merest outlines and, furthermore, refer chiefly to those species which seriously trouble man.

The most fundamental of all measures of protection is the removal of the original source of all mosquito breeding, accumulations of stagnant or sluggishly moving water. The particular measures adopted must vary widely with the type of mosquito to be dealt with. Along the shores of the eastern United States, for example, the salt-marsh mosquito, *Culex sollicitans*, furnishes one of the most important problems from the standpoint of nuisance, although this species is not a carrier of disease. The salt-marsh areas and the neighboring country may be kept reasonably free from mosquitoes by the construction of comprehensive systems of drainage ditches which keep down the water level of the land adjacent and are themselves flushed out by the tide. Fresh water swamps and pools where species of *Anopheles* breed may be treated in a similar way or in some cases may more economically be filled in.

In dealing with the common malarial mosquito of the central United States, *Anopheles quadrimaculatus*, special attention must be devoted to sluggish streams clogged with vegetable growth. If such streams are straightened and cleared of weeds their rapid flow will no longer be suitable for mosquito breeding. On the other hand the *Culex pipiens* and *Aëdes calopus* are house mosquitoes, and the most important measure in checking these insects is the removal of small accumulations of stagnant water in the immediate neighborhood of habitations. Such inconspicuous breeding places may produce in the aggregate great numbers of mosquitoes; and every anti-mosquito campaign must include provision for systematic house-to-house inspection if it is to be successful.

Watch, then, for unused barrels, tubs, and buckets; roadside puddles; hoof prints, ruts, and depressions of all sorts; barn-yard pools; and the like. In cities, special attention must be paid to the catch basins of street sewers which are often prolific breeding places. In attempting to locate wrigglers in such places water should be skimmed (not scooped) from the margins of the water in a white-lined cup or dipper. Fountain-basins should contain goldfish since these fish are voracious feeders on mosquito eggs and larvæ, or the basins should be emptied and thoroughly dried at least once a week

Fig. 19. OILING A MOSQUITO-BREEDING SWAMP

during the mosquito season. If for any reason a pool or pond cannot be drained there are two principal methods of preventing it from furnishing the neighborhood with mosquitoes: the surface may be covered once a week with a film of oil; or surface-vegetation may be removed, the sides of the pool made sharp and steep, and the pool well stocked with goldfish. The first method is not entirely satisfactory since the oil must be renewed so often, and also because an oiled pool has an unpleasant look and odor. Kerosene spreads well but evaporates quickly: crude oil lasts longer but does not

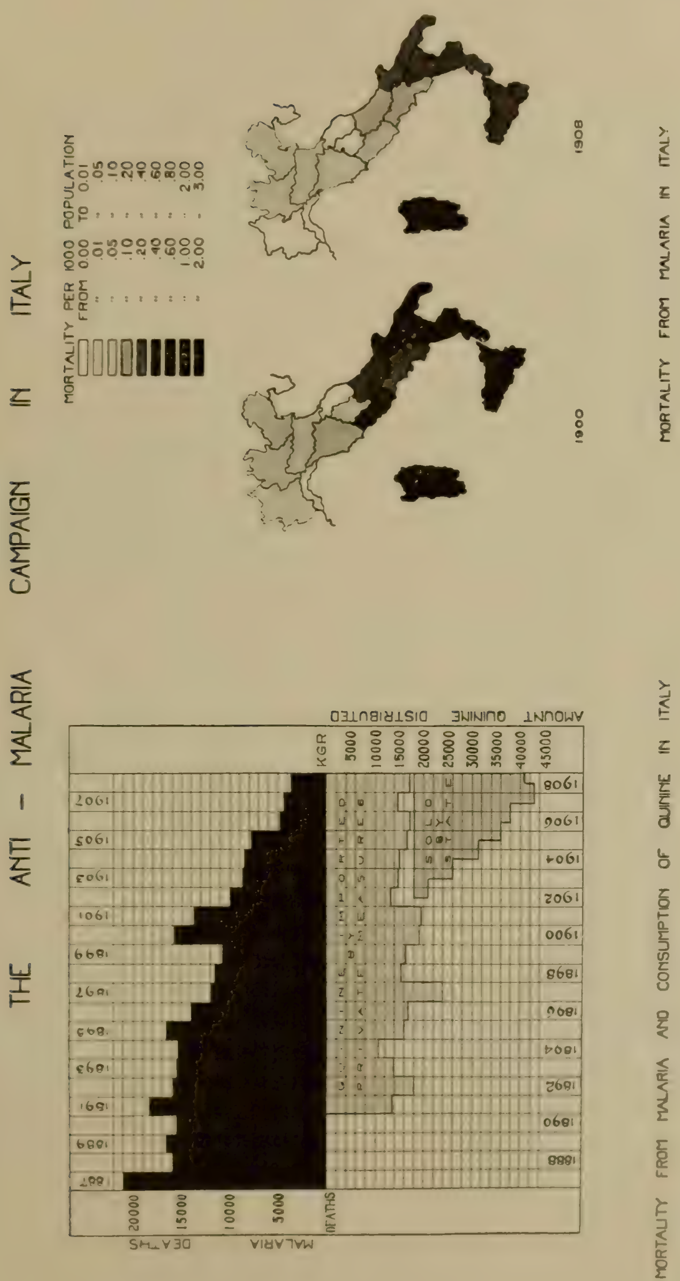
spread so well and larvæ survive between the patches of oil. A mixture of about equal parts of kerosene and crude oil is rather satisfactory. It should be applied with a spray-pump. Very few, if any, of the numerous patented oils are worth the money. "Larvicide" is made from crude carbolic acid; it was used in the Panama Canal work, but water treated with it is poisonous to stock.

Of all the natural enemies of mosquitoes, fish are the most important, and of these goldfish are the most dependable and easily secured, but small ones are much better than large ones. Top minnows, such as species of *Gambusia* and *Heterandria* (*Fundulus*) are the most important natural enemies of mosquitoes. It is true that numerous aquatic insects feed, to some extent, on mosquito larvæ and pupæ, but they are rarely numerous enough to be of much value, and their numbers cannot easily be increased in any given pool. The usefulness of dragon-fly larvæ and adults has been greatly exaggerated. Tadpoles are vegetarians and do not make a practice of eating larvæ.

Since *Anopheles* larvæ frequently live in water which flows rapidly enough to wash away oil, and since they keep close to the surface of the water, getting above leaves of aquatic plants where fish do not see them, they are rather difficult to control. To make matters worse, they are the mosquitoes which we are particularly anxious to get rid of since they are the only ones known to carry disease in the North. Cleaning the edges of streams or ponds, clearing away aquatic vegetation, and keeping a good stock of fish seem to be the only feasible methods of control, although in small brooks a constant supply of oil may be furnished from a specially designed automatic drip can.

In regions where malaria or yellow fever or any other mosquito-borne disease prevails, such measures should be supplemented by careful exclusion of mosquitoes by the use of window screens and bed canopies, and special precautions should be taken to prevent the biting of those suffering from disease by mosquitoes which may carry the infection to others.

The application of these various methods of mosquito control, with thoroughness and over sufficient areas, has yielded results of the most definite and tangible kind. In the Italian Campagna the proportion of the population infected with malaria was reduced from 65% to 12% by measures directed toward the eradication of the *Anopheles* mosquito and was then brought down to 4% by the free distribution and vigorous advertisement of the value of prophylactic doses of quinine. Between 1902 and 1908 the deaths from malaria in the whole kingdom of Italy fell from 16,000 to 4,000.



THE ANTI - MALARIA CAMPAIGN IN ITALY
MORTALITY PER 1000 POPULATION
1900
1908
MORTALITY FROM MALARIA IN ITALY
MALARIA DEATHS
AMOUNT QUININE DISTRIBUTED
MORTALITY FROM MALARIA AND CONSUMPTION OF QUININE IN ITALY

Fig. 20

THE CONQUEST OF YELLOW FEVER

The discovery of the mosquito transmission of yellow fever is one of the most striking and dramatic chapters of sanitary science and one of the brightest episodes in the history of our country.

Between the years 1702 and 1800 this terrible disease had appeared in the United States thirty-five times and between 1800 and 1879 it visited the country every year with two exceptions. In 1793 a tenth of the population of Philadelphia are said to have perished from its ravages.

Mathew Carey writes of this epidemic, "the consternation of the people of Philadelphia at this period was carried beyond all bounds. . . . . People hastily shifted their course at the sight of a hearse coming towards them. Many never walked on the foot-path but went into the middle of the street, to avoid being infected in passing by houses wherein people had died. Acquaintances and friends avoided each other in the streets and only signified their regard by a cold nod. The old custom of shaking hands fell into such disuse that many shrunk back with affright at even the offer of the hand. A person with a crêpe, or any appearance of mourning, was shunned like a viper. And many valued themselves highly on the skill and address with which they got to the windward of every person they met. Indeed, it is not probable that London, at the last stage of the plague, exhibited stronger marks of terror than were to be seen in Philadelphia from the 24th or 25th of August till pretty late in September."

The Philadelphia epidemic was the occasion of a vigorous discussion as to the contagiousness or non-contagiousness of the disease in which the eminent Dr. Benjamin Rush was finally converted from the latter to the former view. For over a century arguments were advanced pro and con, without conclusive result, and as late as 1898 the United States Marine Hospital Service summed up the matter as follows: "While yellow fever is a communicable disease, it is not contagious in the ordinary acceptation of the term, but is spread by the infection of places and articles of bedding, clothing and furniture. . . . . One has not to contend with an organism or germ which may be taken into the body with food or drink, but with an almost inexplicable poison so insidious in its approach and entrance that no trace is left behind."

Fig. 21. WALTER REED

Fig. 22. JESSE W. LAZEAR

Fig. 23. JAMES CARROLL

Fig. 24. ARISTIDES AGRAMONTE

Two years later, early in the year 1900, a commission of army officers was appointed to study the disease in Havana as a result of a number of cases which had occurred among the American troops stationed there. The Chairman of the Commission was Dr. Walter Reed, and his associates were Dr. James Carroll, Dr. Jesse W. Lazear, and Dr. Aristides Agramonte. At the very beginning, the investigators turned their attention to the mosquito as a possible agent in the transmission of the disease. Dr. Carlos J. Finlay of Havana had suggested the mosquito theory of yellow fever very convincingly in 1881, though without experimental proof, and the discoveries of Manson and Ross and Grassi and Bignami had recently demonstrated a similar origin for malaria. Reed and his colleagues were fortunate in thus beginning almost at once with a correct hypothesis.

The lower animals do not suffer from yellow fever, so that experiments upon human subjects were essential. In the words of Dr. Kelly's life of Major Reed, "after careful consideration, the Commission reached the conclusion that the results, if positive, would be of sufficient service to humanity to justify the procedure, provided, of course, that each individual subjected to experiment was fully informed of the risks he ran, and gave his free consent. The members of the Commission, however, agreed that it was their duty to run the risk involved themselves, before submitting anyone else to it."

The first successful experiment was made with Dr. Carroll, who allowed himself to be bitten on August 27 by a mosquito which had previously bitten four yellow fever patients. Four days later he was taken sick and for three days his life hung in the balance. Both he and Private W. H. Dean, the second case produced experimentally in the same way, recovered. Dr. Lazear, however, who came down with the disease, not as a result of the experimental inoculations to which he also had submitted, but from an accidental bite, was less fortunate than his colleagues, for a week later he died, after several days of delirium with black vomit.

An experimental station, named "Camp Lazear" after this first martyred member of the party, was established in the open country; and to the lasting honor of the United States Army, volunteer subjects for the experiments from among the troops were always in excess of the demand. Private John R. Kissinger and John J.

Moran, a civilian employee, were the first to volunteer "solely in the interest of humanity and the cause of science," their only stipulation being that they should receive no pecuniary reward.

The result of the experiments carried out at Camp Lazear proved beyond peradventure that yellow fever was transmitted by the bite of a certain mosquito, *Aedes calopus*, and in no other way, for non-immunes who lived for twenty days in a small, ill-ventilated room, in which were piled clothing and bedding, loathsome with the discharges of yellow fever patients, all escaped infection, so long as they were protected from the bites of mosquitoes.

On the memorial tablet to Lazear in the Johns Hopkins Hospital is the inscription: "With more than the courage of the soldier, he risked and lost his life to show how a fearful pestilence is communicated, and how its ravages may be prevented." The same risk was freely taken by each member of the party from major to private. The result of their devotion is indicated in two of Reed's letters to his wife, "six months ago, when we landed on this island, absolutely nothing was known concerning the propagation and

Fig. 25. CAMP LAZEAR WHERE THE SECRETS OF YELLOW FEVER WERE REVEALED

spread of yellow fever—it was all an unfathomable mystery—but today the curtain has been drawn"; and later on New Year's Eve—"only ten minutes more of the old century remain. Here have I been sitting reading that most wonderful book, 'La Roche on Yellow Fever,' written in 1853. Forty-seven years later it has been permitted to me and my assistants to lift the impenetrable veil that has surrounded the causation of this most wonderful, dreadful pest of humanity and to put it on a rational and scientific basis. I thank God that this has been accomplished during the latter days of the old century. May its cure be brought out in the early days of the new."

The practical result of this discovery was immediate and striking. In the half century or so for which we have records, yellow fever had killed an average of 750 persons a year in the City of Havana. The sanitary reforms introduced by the American army of occupation which produced good results in reducing typhoid and smallpox had been powerless against yellow fever because its cause was as yet a mystery. Following immediately on the experiments at Camp Lazear, on February 15, 1901, a campaign was begun on the new lines indicated, by screening the rooms occupied by yellow fever patients and destroying all mosquitoes in the neighborhood. As a result there were six deaths in the City of Havana during the year 1901 as against 305 in the preceding year, and although sporadic cases have been introduced from other localities, yellow fever has never again established itself in Havana. The scourge of centuries was wiped out in a single year.

THE SUCTORIA OR FLEAS

The Suctoria or fleas are small, wingless, jumping insects which are strongly compressed sideways. They are all parasitic, when adult, on warm-blooded animals; but the footless, worm-like larvæ are not. Adults of both sexes have piercing mouth-parts and suck blood. The larvæ, however, have chewing mouth-parts and feed on more solid organic material. The larvæ live in dust and refuse on the floor or ground and pupate there, usually in thin silken cocoons.

The Dermatophilidæ, one of the principal families of Suctoria, have the segments of the thorax much shortened and constricted, but the side-plates of the metathorax extend over two or three abdominal segments; the third antennal joint has no completely separated false joints; and the fully developed female, living beneath the skin of her host during her final development, has a greatly dilated abdomen. The most familiar example is *Dermatophilus penetrans*, the "chigoe," "chique," "chigger," "jigger," or "sand-flea." The fertilized female burrows under the skin, especially about the toes, and causes a nasty ulcer. The eggs which she lays in the ulcer, or the larvæ which hatch from them, drop to the ground for further development. The female may be picked or squeezed out of the ulcer and the wound should then be carefully treated to clear away the pus. As a method of control—even if not for other reasons!—the habitations of men and domesticated animals should be cleaned to destroy the larva. This species is found in the warmer parts of America and in Africa. Members of the family Pulicidæ, on the other hand, do not have the thoracic segments much constricted and shortened but the side plates of the metathorax extend over only one abdominal segment; the third antennal joint has nine more or less distinctly separated false joints; the spines on the hind tibiæ are in pairs, are few in number, and are not in a very close-set row; and none of the species burrow under the host's skin. In the genus *Ctenocephalus* both the head and the pronotum (front section of the thorax) have stout, spine-like bristles (ctenidia); the last tarsal joint has four pairs of lateral spines and, in distinction from *Neopsylla*, the eyes are distinct. In *Ceratophyllus* the head has no ctenidia but the pronotum does; the last tarsal joint has five pairs of lateral spines. In *Pulex* and *Xenopsylla* neither the head nor the pronotum has ctenidia. The distinction between these two genera is chiefly based

on internal anatomy. *Ceratophyllus fasciatus* is the rat and plague flea of temperate regions. It feeds on rats, mice, skunks, and man. In America, it seems to be confined to California; but it also occurs abundantly in Europe. *Xenopsylla cheopis* is the tropical rat and plague flea. Although it largely confines its attentions to rats, it also, unfortunately, attacks man. The cosmopolitan human flea (*Pulex irritans*) is most abundant in warm regions, and attacks rats, skunks, and domestic animals as well as its normal prey, man. The cat and dog fleas, *Ctenocephalus canis* (female's head less than twice as long as high) respectively, are common parasites.

Fig. 26. MODEL OF THE FLEA (*Pulex irritans*)
American Museum of Natural History

THE BLACK DEATH AND ITS CONTROL

Of all the insect-borne diseases, the one that has proved in the past most deadly to mankind is bubonic plague, a malady closely bound up with the activities of the insect pests which have just been discussed. We have records of the ravages of this disease from very early times. The countries of the Levant have been centers of plague infection for 3,000 years as a result of their unique position as gateways between the East and the West. Plague among the Philistines is described in the First Book of Samuel, the golden images of tumors and of mice, prepared as sacrificial offerings, referring clearly to one of the characteristic symptoms of the disease and to its prevalence among rodents.

Fig. 27. THE PLAGUE AT EPIRUS. P. MIGNARD (1610-1695)

The first fully recorded pandemic of plague broke out at Pelusium in Egypt in 542 A. D. and spread by way of the principal trade routes of the time into Palestine and then to the rest of the known world. Procopius says of this outbreak, of which he was a witness "It spared neither island nor cave nor mountain top where man dwelt. . . . Many houses were left empty and it came to pass that many from want of relatives and servants lay unburied for several days."

The second pandemic of plague, the Black Death of the Middle Ages, originated in Mesopotamia about the middle of the eleventh century. In the track of travel and commerce, particularly on the route of the returning crusaders, it quickly spread to the West and North. It is said that 25,000,000 people, one fourth of the population of Europe, perished of plague during the fourteenth century.

A third pandemic of plague which is still going on at the present time (1918) broke out at Yunnan Fu in China in 1871 and attracted general notice when it reached Hongkong in 1894. From this point

Fig. 28. MODEL OF CORNER OF RAT-INFESTED DWELLING
American Museum of Natural History

the disease made its way to India where it raged unchecked for ten years and carried off 6,000,000 people. This time, however, the world invasion of the Black Death was to be met by a new defensive mechanism, the organized force of scientific research. A Japanese bacteriologist, Yersin, discovered the bacillus of plague in 1894 and it was soon proved that the disease from which rats were simultaneously suffering (as they had done in the days of Samuel) was the same as the human plague. The infection may be more or less chronic among the rodents, persisting among them for years as

tuberculosis infection does in man. At certain times and under certain conditions, the disease becomes more virulent, the rats die in great numbers, and infection spreads to human beings. The agent of transmission of the germ from rat to man and from man to man remained to be solved; and in 1897 and succeeding years evidence accumulated by a number of French, English, and Russian investigators began to point more and more strongly toward the flea

Fig. 29. HABITAT GROUP OF CALIFORNIA GROUND SQUIRRELS
(*Citellus variegatus beecheyi*)
American Museum of Natural History

as the intermediate carrier of the germ. Finally the experiments of the Indian Plague Commission rendered this practically certain, for they showed that infection did not spread from a sick to a well rat even when in intimate contact if fleas were absent, while if they were present, the exposed animals quickly came down with the disease. In man it is now known that plague may at times (as in Manchuria) develop a peculiar "pneumonic" type in which the

germs are discharged from the mouth and nose as in the case of a common cold. Pneumonic plague, therefore, spreads directly from man to man by contact, but in the ordinary or "bubonic" plague the germs are not discharged in any of the excretions of the body and can only be transmitted by the flea. In northern Asia the rodent host of the plague bacillus is the Siberian marmot or tarbagan, *Arctomys bobac*, and the first human victims in Manchuria were trappers and dealers in marmot skins. In California, the ground squirrel, *Citellus variegatus beecheyi*, is infected, and the United States Public Health Service up to September, 1913, had isolated plague bacilli from 1891 different individuals. A number of human

Fig. 30. SHIP EQUIPPED WITH GUARDS ON THE HAWSERS TO PREVENT LANDING OF INFECTED RATS

cases in California were traced to infection from these animals. The most important carriers of plague germs, however, are the various rats, the black rat (*Mus rattus*), the common rat of the middle ages in Europe, the brown rat (*M. norvegicus*), which has now generally supplanted the smaller and less ferocious black rat, and the roof rat (*M. alexandrinus*) which has established itself at many seaports.

The modern campaign against plague depends mainly upon the control of the rodent host. Human cases must of course be isolated but the great essential is that possibly infected rats on incoming ships should be excluded from the wharves by rat-guards on the hawsers, and rats on board destroyed by fumigation. In seaports, or other

cities where plague infection is likely to enter, comprehensive campaigns must be organized for the removal of breeding and harborage places of rats by cleaning up rubbish, for the starving out of rats by covering garbage and eliminating other accumulations of food, for trapping and shooting and poisoning rats, and for excluding rats from buildings by various forms of ratproof construction. The natural enemies of the rat,—cats, dogs, and ferrets, skunks, foxes, coyotes, weasels, minks, hawks, owls, snakes, and alligators—are often of great assistance in this campaign.

Fig. 31. THE SECOND PANDEMIC OF PLAGUE.
EXTENSION OF THE DISEASE BETWEEN 1200 AND 1450 A. D.

These methods of rat suppression have been widely successful in their application to the control of bubonic plague. The early history of the present pandemic of plague is precisely like that of the one which began in the eleventh century. It started in China, spread to Manchuria in one direction, and killed its six millions in India. Thence, following the trade routes as of old, plague infection has been carried to seaports all over the world. It has

passed east to Melbourne, Brisbane, and other Australian cities, north to Portugal and Scotland, and around the world to Brazil, Porto Rico, California, and New Orleans. We are actually to-day in the midst of a potential world pandemic of plague like that of the Middle Ages; but our knowledge of the relation of the rat to this disease has made it easy to prevent general spread in any of the countries into which infection has been introduced outside of Asia.

Fig. 32. THE THIRD PANDEMIC OF PLAGUE.
EXTENSION OF THE DISEASE BETWEEN 1897-1917.

Fig. 33. MODEL OF THE BODY LOUSE (*Pediculus vestimenti*)
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LICE AND BED-BUGS

Another group of insects, of great importance in connection with disease, is the family of Siphinculata known as sucking lice or Pediculidæ. They are small, more or less flattened, wingless parasites which have an unjointed, fleshy beak barely reaching the thorax. The five-jointed antennæ are short; the tarsi are single-jointed, forming a claw at the end of the tibiæ; the eyes are well developed, convex, and distinctly pigmented. The eggs, "nits," are fastened on the hair or clothing of their host. The metamorphosis is slight so that the newly hatched young closely resemble the adults, and there is no resting, pupal stage. Three or four weeks is usually sufficient time for these creatures to reach maturity from the time the egg is laid. The head-louse, *Pediculus capitis*, is more common

on the children of cleanly families than is generally admitted and it is almost the rule among the less cleanly, The former get it from the latter by contact, by using the same comb or brush, by hanging the hat on the same rack in school and in other ways. The body-louse or gray-back, *Pediculus vestimenti* (or *corporis*) is common where men gather in numbers without having, or using, adequate facilities for cleanliness. Cleanliness, in this case, refers very largely to the clothing, as this species lays its eggs on the clothes next to the skin and the lice themselves spend much of the time there. The crab-louse, *Phthirius inguinalis*, is an easily recognized species, the common name being appropriate. It infests the pubic regions and the armpits of man. Transmission sometimes occurs by way of public toilets.

The use of a fine-toothed comb dipped in kerosene is an effective remedy for the head-louse. The treatment should be repeated twice at intervals of a week. For body-lice, the clothing should be boiled, steamed, fumigated, or soaked in gasolene or benzine. The irritation caused by the lice may be relieved by a lotion of one half ounce of borax to a pint of water. In dealing with these lice when there is danger of typhus fever, the greatest care must be exercised to prevent their spread. The face and the head should be shaved and the hair burned. A liberal use of kerosene on floors and about beds is recommended. The crab-louse may be treated in the same way as the head-louse but mercurial or "blue" ointment is often used. The salve should not be strongly rubbed in or used directly after a warm bath. Vinegar makes the eggs of the lice more susceptible to treatment.

The Bed-bug, *Cimex lectularius*, an insect belonging to the Hemiptera, has received many more or less descriptive names in addition to that of "bed-bug." Some of them are "wall-louse," "red-coat," "mahogany flat," "chinch," and just "bug." Most people are familiar with this insect, whether they admit it or not; others usually recognize it, by instinct or by its reputation, the first time they meet it. There is a mistaken idea that the flat, dark-colored insects to be found under the bark of decaying logs, and the ones that occur in the nests of swallows, belong to the species under discussion. Another mistaken notion is that these creatures may become "grandfathers in a night." The eggs, which are white and oval in outline with a rim around the free end and sculpturing over

the shell, are laid in cracks and crevices in beds and in bedrooms. These eggs hatch in about a week. The young resemble the adults, except in size, and there is no pupal stage. After molting five times, the adult stage is reached; this growth takes a month or more, depending on temperature conditions and the amount of available food—the blood of man, and, if necessary, of other warm-blooded animals such as mice and poultry. Bed-bugs have been kept alive and active for a year in a tight box without any food at all. Kerosene, gasolene and benzine are effective remedies, if forced into the crevices where the bugs hide by day. The treatment should be repeated at intervals of about a week, since the eggs often withstand this treatment. For killing them on a large scale, there is nothing better than fumigation with hydrocyanic acid gas, but this is a deadly poison for man as well and should be used with caution. Those desirous of trying it should write to their State Entomologist or to the Bureau of Entomology, United States Department of Agriculture, for detailed instructions.

The bed-bug has a few natural enemies; these enemies are, however, not greatly to be preferred to the bed-bug itself. "Kissing bug," of much newspaper fame a few years ago, is a name applied to several insects which prey upon the better known pest. The "masked bed-bug hunter," *Reduvius personatus*, is one of these. The "big bed-bug" of the South, *Triantoma* (=*Conorhinus*) *sanguisuga*, is much more given to sucking human blood. "It is about an inch long; black, marked with red on the sides of the prothorax, at the base and apex of the front wings, and at the sides of the abdomen; the head is long, narrow, cylindrical, and thickest behind the eyes. It is said that the effects of its bite may last for nearly a year, and it is probable that attacks which are attributed to spiders are really the work of this insect. Out-of-doors, it feeds on insects, including grasshoppers and potato beetles" (Lutz, "Field Book of Insects").

TYPHUS FEVER AND OTHER DISEASES CARRIED BY THE LOUSE

Typhus fever, known also as ship fever, camp fever, and jail fever, was one of the deadliest of the diseases of the Middle Ages. Wherever men were crowded together under the filthy conditions which surrounded our ancestors, this pestilence raged. In sinister alliance with famine, it scourged unhappy Ireland so persistently that it was known as "Irish ague." In England its contagion was spread even through the law-courts, and several notable outbreaks among judges, lawyers, and spectators were dubbed the "Black Assizes" during the sixteenth century. In Tuscany, between 1550 and 1554, more than a million people are said to have died of typhus.

Professor Curschmann says of this malady, "between 1846 and 1848 more than a million cases of typhus occurred in England and more than 300,000 in Ireland, the outbreak starting after the great famine of the earlier year. In every century typhus fever has followed in the wake of armies. During the Thirty Years' War it claimed more victims than did the weapons of the contestants. It was the terror of the Napoleonic campaigns and decimated the French Army, already demoralized physically and morally by the terrible retreat from Moscow. During the Crimean War it decimated both the French and English armies, especially the former."

Dr. R. Bruce Low describes the experience of France with "camp fever" as follows: "When the French in 1812 began their historical retreat from Moscow, they had at least a thousand fever cases among them, and by the time they reached Vilna many other attacks had occurred with numerous deaths. At the beginning of December, 1812, the Russians had taken 30,000 French prisoners, many of whom were ill of fever. The hospitals at Vilna were overflowing with the sick, who suffered greatly from cold and lack of food. Many had no bed or bedding, and had to lie on rotten straw, sometimes side by side with the dead. Of 25,000 cases sent to hospitals at Vilna, less than 3,000 were alive at the end of January, 1813. From the troops the disease in many instances spread to the civil population. For example, in the fortified town of Metz no fewer than 7,752 soldiers of the garrison died of typhus during 1814, as well as 1,294 other persons in the civil hospitals. From Metz the infection spread to the neighboring districts, and by the end of the year no fewer than 10,329 deaths from typhus had occurred in the

Department of the Moselle. In the years following the Napoleonic wars the disease broke out from time to time in different parts of the country, and showed special incidence among the inmates of convict prisons and local jails. In 1848 an outbreak of typhus was started by a prisoner at Amiens, who infected the judge, the clerk of the court, as well as several gendarmes and prisoners. Similar outbreaks occurred at Rheims, Toulon and elsewhere in connection with civilian prisoners.

"The next importation of typhus fever to France on a large scale by troops occurred on the return of the French military forces from the Crimea, where they had suffered severely from the disease. It is reported that out of an effective force of 120,000 men at least 12,000 were attacked by typhus during the campaign, and that half that number died.

"Following upon the return of the troops, outbreaks of typhus occurred at Marseilles, Toulon, Avignon, Paris and elsewhere."

Gradually and without any intelligently directed effort to control its spread, but apparently as a by-product of the generally improved sanitary conditions of living, typhus fever almost disappeared from civilized countries. "Typhoid" fever, named from its resemblance to the more deadly typhus, with which it was once confused, remains a serious menace, but typhus was almost forgotten in western Europe until war broke out in 1914. The table below from Doctor Bruce Low shows how the deaths from this disease have decreased in England and Wales and in Ireland.

DEATHS FROM TYPHUS FEVER IN

	England and Wales	Ireland
1869-1883	23,702	11,544
1884-1898	2,249	4,703
1899-1913	390	1,043

In certain parts of the world, however, where sanitary conditions remain primitive, typhus has held its own. It has occasionally found its way into central Europe from Poland and Galicia. In many districts of Mexico it has long been a serious scourge; and an infection, known as Brill's disease, which occurs in New York City, has been shown to be a mild form of typhus.

Many of the characteristics of typhus fever pointed to the probability of an insect carrier, and suspicion was finally fastened upon the louse as the most probable culprit. The coincidence between

the seasonal and geographical distribution of the disease and the insect, in particular, seemed significant, high temperature apparently being inimical to each. At last in 1909 Nicolle, Comte and Conseil succeeded in transmitting typhus fever to monkeys by the bite of the body-louse. This result was confirmed in the next year in this country by Ricketts and Wilder; and Goldberger and Anderson showed that not only the body louse (*Pediculus vestimenti*) but also the head louse (*Pediculus capitis*) may transmit the specific infection. As an illustration of the danger to which those who work on the insect-borne diseases are exposed, it may be noted that one of this group of devoted experimenters, Howard T. Ricketts, contracted the disease in the course of his investigations and died, almost at the outset of a brilliantly promising career.

With the outbreak of the European War in 1914, typhus again came into public notice as it broke out in malignant form on the eastern battle-front. Its effects upon the course of campaigns in the Balkans is said to have been very material; but the French, German and Russian armies have been protected against its ravages by elaborate provisions for the destruction of lice by the disinfection of clothing and the cleansing and disinfection of the person, particularly of the hair.

The body louse usually conceals itself in the folds of the clothing, depositing its eggs along the seams and wrinkles. A female may deposit nearly 300 eggs which hatch in 3-4 days and reach maturity in 15-18 days. According to recent studies reported in English medical journals,* lice are able to live without food for 2-6 days. They become rigid with cold at 10° F. and are killed in 2-6 hours at 104° F.

Among the various substances which have been employed for the destruction of lice, the most efficient appear to be a killing powder composed of 96 per cent. naphthalene, 2 per cent. creosote, and 2 per cent. iodoform, and an ointment known as vermijelli. The soldier's clothing and equipment may be freed from lice by treatment in either dry or moist heat sterilizers or in special sterilizers which make use of the simultaneous effect of heat and formaldehyde in vacuo. Ironing the seams of garments with a hot iron is a simple and generally effective method. Military encampments are usually provided with special stations for "delousing" or "depediculization,"

*An excellent review of recent contributions to the biology of the louse is to be found in "Household and Camp Insects" by E. P. Felt, Bull. No. 194, New York State Museum.

so arranged that while the men are being bathed their clothes are simultaneously freed from lice by one of the methods described above.

In addition to typhus, a form of relapsing fever is not uncommonly spread in Russia and in other countries of southeastern Europe by the bite of the louse, and this disease has offered one of the serious problems of army sanitation on the eastern front.

OTHER DISEASES TRANSMITTED BY ARTHROPODS

In addition to the insect-borne diseases mentioned above, there are many other diseases of tropical countries, which are transmitted in a similar way by insects or by their relatives, the ticks. Among the most important of these are sleeping sickness and other diseases caused by the Protozoan parasites of the genus *Trypanosoma*, and transmitted by the biting flies of the genus *Glossina*, and certain forms of relapsing fevers and similar maladies, caused by spirochætal parasites transmitted by ticks.

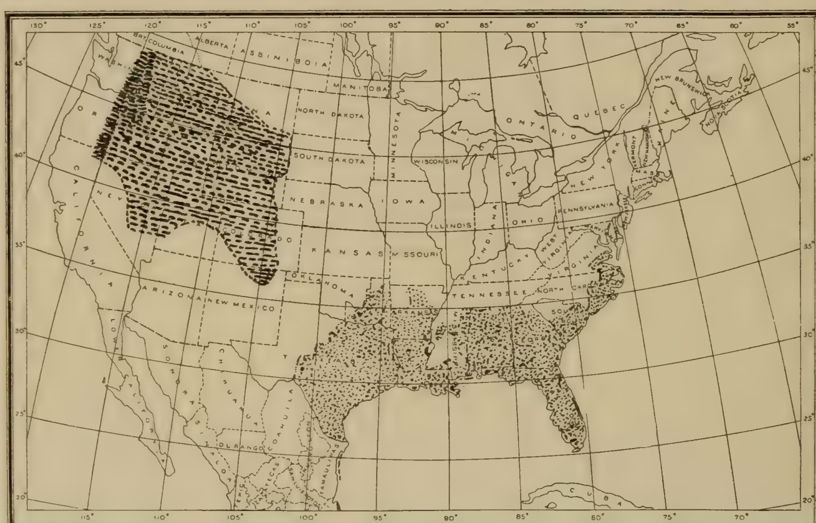


Fig. 34. DISTRIBUTION OF TEXAS FEVER OF CATTLE AND ROCKY MOUNTAIN TICK FEVER

The ticks are not insects at all but belong to the Acarina or mites (see page 4). The first of all the arthropod-borne diseases to be definitely worked out was the serious cattle plague, known in our Southwestern States as Texas fever and in Australia as redwater fever. In 1889 Smith and Kilbourne showed that the causative agent in this disease was a Protozoan parasite (*Babesia*) and that it was carried by the bite of a tick, *Boophilus annulatus*. Rocky Mountain spotted fever, which attacks visitors to the Bitterroot Valley and other areas in the Mountain States, is spread by *Dermacentor andersoni* and other ticks. The most terrible of tick-borne diseases, however, are the African tick fevers or relapsing fevers caused by different species of spirochætes.

Fig. 35. THE TSETSE FLY *(Glossina morsitans)*

Fig. 36. TYPICAL BREEDING PLACE OF GLOSSINA ON THE BELGIAN CONGO

The head- and body-lice, as has been indicated, are the agents in the transmission of typhus fever and are probably active in the spread of European relapsing fever as well, while the body-louse is believed to play a part in the transmission of the special form of relapsing fever which occurs in northern Africa. Bed-bugs (*Cimex*) and assassin-bugs (*Conorhinus*) are probably the agents in disseminating Opilaçao or Chagas fever in Brazil and Kala-azar or dum-dum fever in India and China.

Of the trypanosome diseases, the most important are the cattle disease of South Africa, Nagana, carried by *Glossina morsitans*, and the sleeping sickness of man. It is estimated that between 1900 and 1910 there were 200,000 deaths from sleeping sickness in the Uganda Protectorate alone. The particular trypanosome which causes this malady is carried by another biting fly, *Glossina palpalis*, which lives in rather sharply limited areas of dense forest and undergrowth along the shores of lakes or rivers. Clearing the jungle for a hundred yards along the water courses and for three hundred yards about all villages, screening of houses, protection of the body against bites, and the isolation of the sick are among the most important preventive measures in use against this disease. Surra, a cattle disease of Asia, Malaysia, and the Philippines, somewhat similar to Nagana, is a trypanosome disease spread by various blood-sucking flies, while sand flies (*Phlebotomus*) carry the unknown germs of the Pappatici fever of the Mediterranean and Verruga in Peru. The suspicion that epidemic anterior poliomyelitis (infant paralysis) and pellagra are causally connected with biting flies (*Stomoxys*, *Simulium*) has, on the other hand, not been substantiated.

Among the mosquitoes, besides the various species of *Anopheles*, which carry the germs of malaria, and the *Aëdes*, which transmits yellow fever, *Culex fatigans* spreads the virus of Dengue fever, and with other mosquitoes is the agent in transmitting the microscopic worms (*Filaria*) which cause elephantiasis and other forms of filariasis.

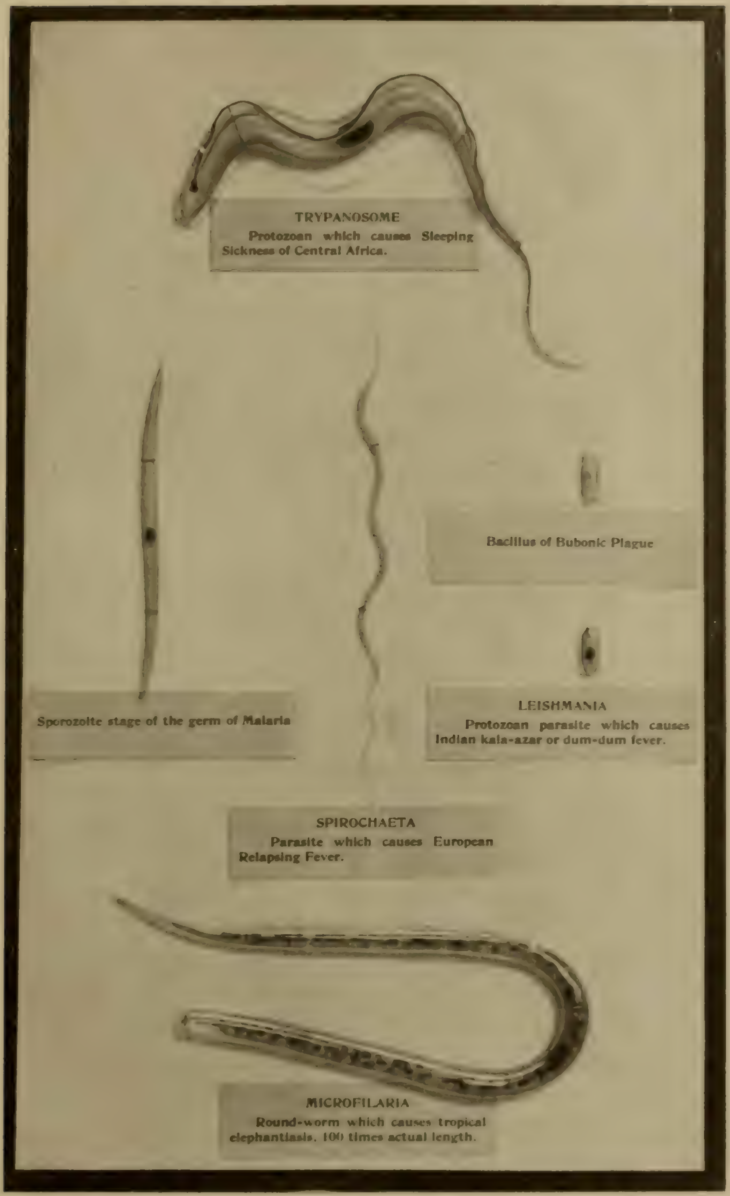


Fig. 37. MODELS OF BLOOD PARASITES
American Museum of Natural History

Tabular Review of Principal Insect-Borne Diseases

DISEASE	PARASITE	CARRIER
		ACARINA (mites)
West African Tick Fever	*Spirochæta duttoni*	*Ornithodorus moubata*
Rocky Mountain Spotted Fever	....	*Dermacentor andersoni* and other ticks
Opilaçao (or Chagas Fever)	*Trypanosoma cruzi*	*O. moubata*, also certain Hemiptera
Texas Fever of cattle	*Babesia bigeminum*	*Boophilus annulatus*
Spirochætosis of fowls	*Spirochæta gallinarum*	*Argas persicus*
		HEMIPTERA (bugs)
Typhus Fever	....	*Pediculus capitis, P. vestimenti*
Opilaçao (or Chagas Fever) of Brazil	*Trypanosoma cruzi*	*Conorrhinus megistus, Cimex lectularius, C. hemipterus*, also certain ticks
European Relapsing Fever	*Spirochæta recurrentis*	*P. capitis, P. vestimenti*, also, perhaps, bedbugs
North African Relapsing Fever	*Spirochæta berberi*	*Pediculus vestimenti*
Kala-Azar or Dum-Dum Fever	*Leishmania donovani*	*Conorrhinus rubrofasciatus* or *Cimex hemipterus* (?)
		SIPHONAPTERA (fleas)
Bubonic Plague	*Bacillus pestis*	*Xenopsylla cheopis* and other fleas
Infantile splenic leishmaniasis	*Leishmania infantum*	*Pulex irritans* and other fleas
		DIPTERA (flies)
Sleeping Sickness	*Trypanosoma gambiense*	*Glossina palpalis*
Nagana disease of cattle	*Trypanosoma brucei*	*Glossina morsitans* and other flies
Surra of cattle	A filterable virus	*Phlebotomus papatasii*
Verruga peruviana	....	*Phlebotomus verrucarum* (?)
Typhoid, diarrheal disease of children, etc.	Various bacteria	*Musca domestica* (occasional accidental carrier)
		DIPTERA (mosquitoes)
Malaria—tertian	*Plasmodium vivax*	*Anopheles maculipennis* and other *Anopheles* sp.
quartan	*P. malariæ*	
æstivo-autumnal	*P. falciparum*	
Yellow Fever	A filterable virus	*Aëdes calopus*
Filariasis	*Filaria bancrofti*	*Culex fatigans, Anopheles nigerrimus* and others
Dengue	A filterable virus	*Culex fatigans*

THE BUILDING OF THE PANAMA CANAL A TRIUMPH OVER INSECT-BORNE DISEASE

By far the most serious problem which confronted the United States Government in the attempt to cut a canal across the Isthmus of Panama was that of insect-borne disease.

The Isthmus was first visited by Columbus on his third voyage in 1498. Permanent settlements were established shortly thereafter by Balboa, and the conquest of Peru, about 1530, by Pizarro made the Isthmus a center of unique commercial importance. The size and magnificence of the city of Old Panama, the point from which Pizarro sailed forth, which Drake half a century later reconnoitred from both its land and water sides, and the stronghold, which the buccaneer Morgan captured, sacked, and practically destroyed in 1671, has been greatly exaggerated by the earlier chroniclers and by later but no less credulous historians. Yet it is certain that an enormous volume of travel and a vast quantity of gold and silver bullion passed across the Isthmus between Spain and her imperial colonies. The result of this constant influx of non-immunes in a region admirably adapted for the breeding of disease-carrying insects might have been anticipated. The Isthmus became "the foremost pest-hole" of the earth, "infamous for its fevers, and interesting only because of the variety of its malarial disorders and pestilences."

The failure of the attempt made by the French under de Lesseps to build an Isthmian Canal (1880-1888) was due to various causes but most of all, perhaps, to the ravages of insect-borne disease. Nothing was then known of the relation of mosquitoes to the transmission of malaria and yellow fever. The hospitals on the Isthmus were unscreened, and potted plants stood all about with water in their saucers, furnishing an ideal breeding-place for *Aëdes* mosquitoes. Even the legs of the beds were stood in cups of water to prevent ants from climbing them. It is no wonder that, as General Gorgas estimates, the French lost about one-third of their white working force each year from yellow fever alone.

When the United States undertook the work, the epoch-making discoveries of Reed and his associates had been established, and General Gorgas, fresh from his successful handling of the sanitation of Havana, was detailed as sanitary adviser to the Isthmian Canal Commission in 1904. It is difficult to believe to-day that the members

of the Commission were at first quite unconvinced by the Havana investigations and the practical application of their conclusions. As the non-immune population on the Isthmus increased, yellow fever became epidemic. In April, 1905, several of the higher officials were stricken, and panic and demoralization threatened. In June, 1905, the Governor and Chief Engineer of the Commission recommended that General Gorgas and other adherents of the "mosquito theory" should be recalled and "men with more practical views" appointed in their places. President Roosevelt, however, supported the sanitary officers with his accustomed vigor, and Mr. John F. Stevens, who was appointed in place of the former Chief Engineer, was in cordial sympathy with General Gorgas' plans. The work now moved forward rapidly. Mosquito breeding was reduced to a minimum by clearing away brush and undergrowth, by draining low lands, and by the use of larvicides. Houses were screened, and in particular malaria and yellow fever patients were rigorously isolated from the access of mosquitoes. Quinine was provided, and its systematic use as a prophylactic was persistently urged upon the working force.

The results of this sanitary work were as strikingly dramatic as those obtained at Havana. In 1904 and 1905 there were 35 deaths of employees from yellow fever on the Isthmus, but by the end of the latter year the situation was under control. In May, 1906, there was one case at Colon and there has not been a single case on the Isthmus since that date.

The deaths from malaria have been reduced from 233 in 1906 to 3 in 1916 with a larger working force, and the table of case rates below quoted from Hoffman's monograph is eloquent of the results achieved.

CONQUEST OF MOSQUITO BORNE DISEASE IN PANAMA

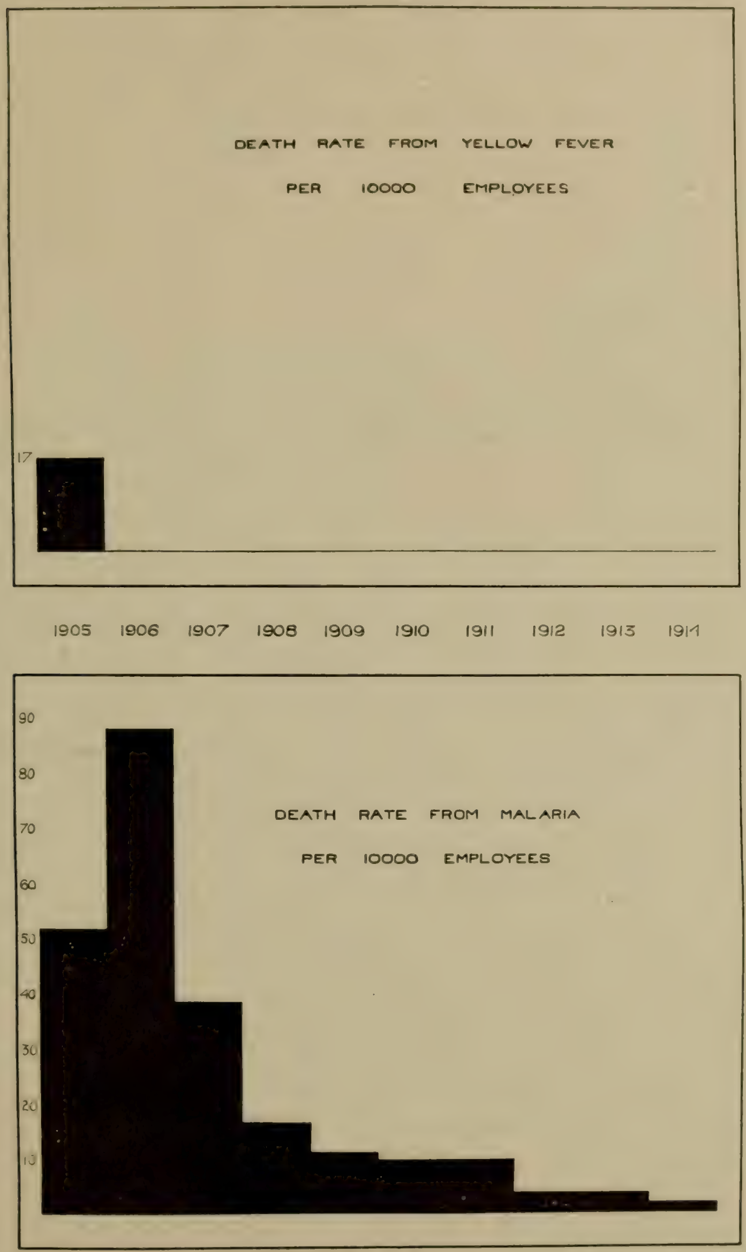


Fig. 38.

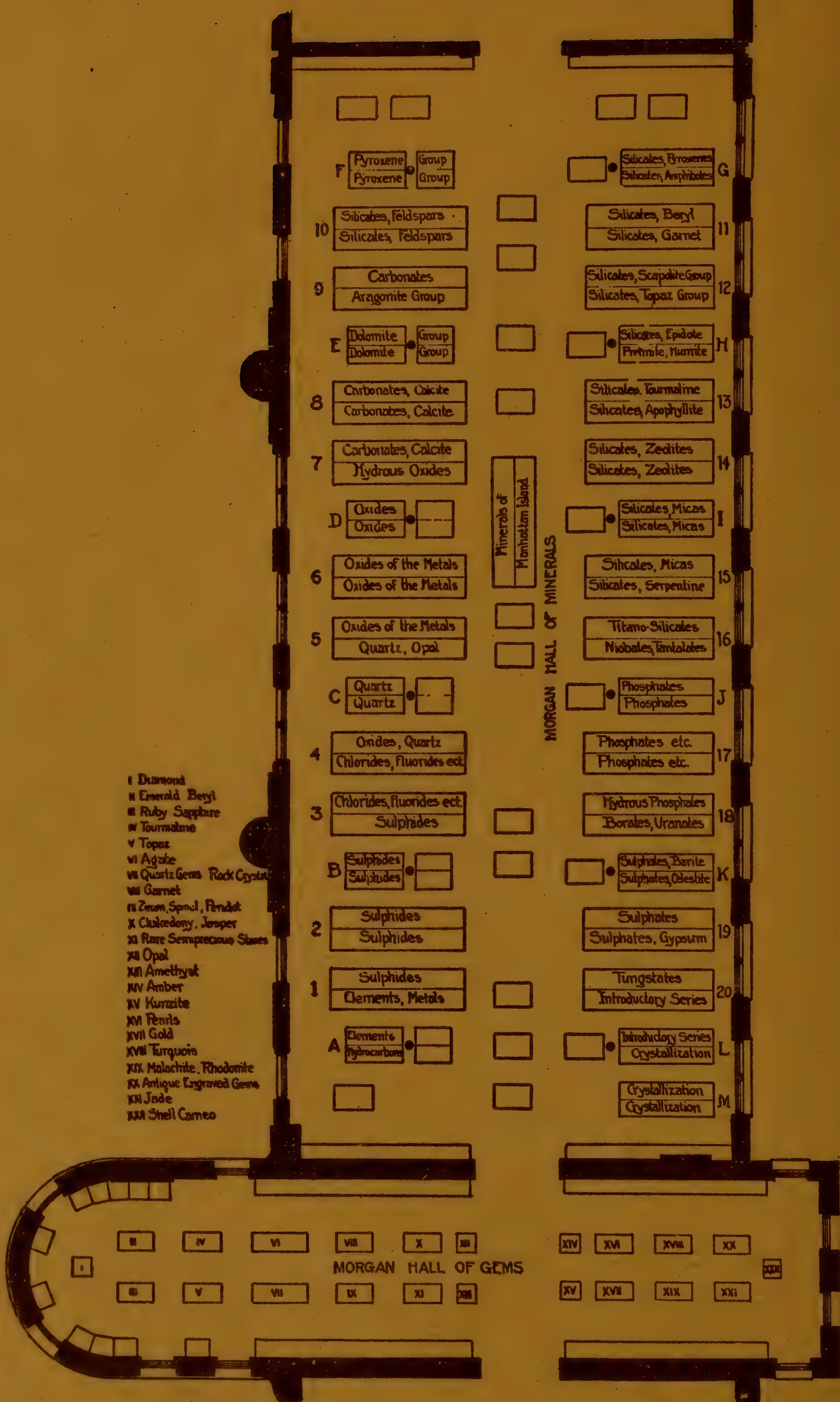
HOSPITAL CASES OF MALARIA AMONG CANAL ZONE EMPLOYEES per 100 employed

Year	Case-rate	Year	Case-rate
1906	81.9	1912	11.0
1907	42.6	1913	7.6
1908	28.2	1914	6.5
1909	21.6	1915	4.5
1910	18.7	1916	1.5
1911	18.4		

General Gorgas estimates that, if our force of 39,000 men had suffered as the French suffered from disease, there would have been 78,000 deaths during the ten years' work on the construction of the Canal. There were actually 6,630 deaths, indicating a saving due to efficient modern sanitation of over 70,000 lives.

The late Charles Francis Adams said of this episode, in an Address before the Massachusetts Historical Society (Proceedings of the Massachusetts Historical Society for May, 1911), "the great and most startling impression left on me by what I saw on my visit to the Zone was not the magnificent ditch itself, nor the engineering feats accomplished; nor yet the construction work in progress. These are remarkable; but solely, so far as I am competent to judge, because of their magnitude and concentratedness. I have frequently seen steam shovels at work; though never so many, nor quite so busily, as now in the Culebra Cut. So I have watched pneumatic drills as they bored into the rock, and heard the detonation of the dynamite; though at Panama more drills would be working at once and in closer proximity than I ever saw before, and the blasts when the day's work was done sounded like a discharge of artillery in battle. For centuries all civilized nations have been building canals and dams, though the Gatun Dam breaks the record for bigness; the locks, too, at Panama are larger and longer, and more elaborate and imposing than any yet designed. All this is true; and yet it failed deeply to impress me. After all, it was a mere question of bigness—the something more or something less; and, as a result of organized energy and systematic coöperation of forces for rapid daily accomplishment, I still think the construction of the Pacific railroads fifty years ago at the rate of half a dozen miles a day, every material, even water, having to be hauled to the moving camp which constituted the advancing front,—

this was by far a more dramatic display than anything now to be seen on the Isthmus. Again, the Gatun Dam is a great conception; but as such the recent tunneling of the Hudson and the subterranean honeycombing of Manhattan Island, combined with the bridging of the East River, impress me more. Finally, the locks at the entrance and outlet of the proposed Chagres Lake are imposing structures; but to my mind the terminal stations built, or now in process of building, in the heart of New York City, are more imposing. As I have said, all this is a mere question of degree, and time out of mind the world has been building roads and water-ways; moreover, behind this particular water-way is the Treasury of the United States. But when it comes to the sanitation which made all that is now going on at Panama humanly and humanely possible,—vanquishing pestilence and, while harnessing the Chagres, also making it innocuous to those working and dwelling on its banks,—this is new; and the like of it the world had not before seen."


MORGAN HALL OF MINERALS
MORGAN HALL OF GEMS
Minerals of Manhattan Island
F Pyroxene Group / Pyroxene Group
G Silicates, Pyroxenes / Silicates, Amphiboles
10 Silicates, Feldspars / Silicates, Feldspars
11 Silicates, Beryl / Silicates, Garnet
9 Carbonates / Aragonite Group
12 Silicates, Scapolite Group / Silicates, Topaz Group
E Dolomite Group / Dolomite Group
H Silicates, Epidote / Prehnite, Humite
8 Carbonates, Calcite / Carbonates, Calcite
13 Silicates, Tourmaline / Silicates, Apophyllite
7 Carbonates, Calcite / Hydrous Oxides
14 Silicates, Zeolites / Silicates, Zeolites
D Oxides / Oxides
I Silicates, Micas / Silicates, Micas
6 Oxides of the Metals / Oxides of the Metals
15 Silicates, Micas / Silicates, Serpentine
5 Oxides of the Metals / Quartz, Opal
16 Titano-Silicates / Niobates, Tantalates
C Quartz / Quartz
J Phosphates / Phosphates
4 Oxides, Quartz / Chlorides, Fluorides ect.
17 Phosphates etc. / Phosphates etc.
3 Chlorides, Fluorides ect. / Sulphides
18 Hydrous Phosphates / Borates, Uranates
B Sulphides / Sulphides
K Sulphates, Barite / Sulphates, Celestite
2 Sulphides / Sulphides
19 Sulphates / Sulphates, Gypsum
1 Sulphides / Elements, Metals
20 Tungstates / Introductory Series
A Elements / Hydrocarbons
L Introductory Series / Crystallization
M Crystallization / Crystallization
I Diamond
II Emerald Beryl
III Ruby Sapphire
IV Tourmaline
V Topaz
VI Agate
VII Quartz Gems Rock Crystal
VIII Garnet
IX Zircon, Spinel, Peridot
X Chalcedony, Jasper
XI Rare Semiprecious Stones
XII Opal
XIII Amethyst
XIV Amber
XV Kunzite
XVI Pearls
XVII Gold
XVIII Turquois
XIX Malachite, Rhodonite
XX Antique Engraved Gems
XXI Jade
XXII Shell Cameo

RHODONITE FROM FRANKLIN FURNACE, NEW JERSEY
A group of richly colored crystals

THE COLLECTION OF MINERALS

IN THE

AMERICAN MUSEUM OF NATURAL HISTORY

By HERBERT P. WHITLOCK
Curator of Mineralogy

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The illustrations of this *Guide Leaflet,* all of which show specimens in the Bement Collection, are reproduced from "A Popular Guide to Minerals," by L. P. Gratacap, A.M.

Through the courtesy of the publisher, copies of this volume, which describes and illustrates the Bement Collection in detail, may be purchased at a considerable reduction on the published price by applying at the Visitors' Room.

THE COLLECTION OF MINERALS

INTRODUCTION

Below the very thin layer of vegetable matter, the function of which is to support life, the mass of our globe, as far as our knowledge of it extends, is composed of a number of inorganic substances which are known as minerals. These singly or in aggregates of two or more make up the rocks which in many places are a conspicuous part of the scenery, and important building material. They furnish us with the raw material from which we derive the metals so useful to us in the arts, and even in their decay they provide many of the soil components necessary to vegetation. But essential as these economic minerals just alluded to are, they form a comparatively small part of the great array of natural compounds which come under the classification of minerals. Every substance to be found upon this earth, which has not been directly formed from animal or plant life, and many which come to us in the form of meteorites from outside the earth's atmosphere, are included in the mineral kingdom. There are over 800 different kinds of minerals known, and the list is constantly being added to as new mineral substances are being found in mines and quarries in every part of the globe. Many of these are very rare, and have only been discovered in one or two places, but some of them, such as quartz, calcite and the feldspars, are widely distributed and common enough to be familiar to almost every one. Most of the known mineral species are to be found in the collection to which this *Guide Leaflet* serves as an introduction, and inasmuch as many of them to the casual eye appear very much the same, a word or two is necessary to enable the visitor to single out some of the characteristics which serve to distinguish them. Although in many instances a mineral, such as for example sulphur, has a characteristic color, it is not difficult to find among the many other species and varieties of minerals one which has almost if not quite the same tint. Color, then, is far from an infallible means of identifying a mineral. Many of the metallic minerals have what is known as a metallic luster, such as the yellow brass-like sheen of pyrite or the black steel gray glint of stibnite. But even this is not an unvarying mark of distinction, for galena, the lead sulphide, has a color and

luster almost identical to stibnite, the antimony sulphide; and many of the ores of the metals, such as smithsonite, the carbonate of zinc, and malachite, the carbonate of copper, show a luster which is not at all metallic. Minerals do, however, possess a property which is very useful in identifying them. With very few exceptions every mineral species has a more or less pronounced tendency to form in solids with regular outlines, smooth bright faces and sharp angles. These solids which are called crystals are distinctive, each mineral having its characteristic series of forms, some occurring in cubes, others in slender needle-like prisms, and others in flat angular plates. Although the very great diversity and intricacy of these crystal forms of minerals are somewhat bewildering to anyone unfamiliar with this highly fascinating branch of science, one soon finds that they are capable of being divided into a small number of very simple groups. A series of models showing some of the more important forms of crystals and their relation and meaning will be found to the right of the entrance to the Mineral Hall.

THE HISTORY OF THE COLLECTION

Like most of the large mineral collections of the world, the collection displayed in the Morgan Hall of Minerals has been the result of slow growth over a considerable period. The nucleus of the present collection was the Bailey Collection, a relatively small series of the commoner minerals, but one which was thoroughly comprehensive and served well in the early days of the Museum to represent this branch of Science. The first large addition came in 1891, when the Spang Collection was purchased and not only more than doubled the number of specimens in the Museum but added many new species to those already displayed. It was in 1900, however, that the Collection took rank as the most complete as well as the richest in notable specimens in America and one of the five best exhibition collections in the world. Through the gift of the late J. Pierpont Morgan, Esq., the Museum acquired the remarkable collection of minerals brought together by Mr. Clarence S. Bement of Philadelphia. This last addition, which comprises a large percentage of the specimens now displayed in the Morgan Hall of Minerals, is famous for the exceptional perfection of the material comprising it. The quality of this material, both from the point of view of its scientific interest and the size and beauty of its examples, may be best understood

when one considers the fact that Mr. Bement, a collector of rare judgment and appreciation, not infrequently purchased an entire small collection in order to acquire a single specimen of unique value. Since the gift of the Bement Collection many additions of exceptional beauty and interest have been acquired by purchase from the Fund established in 1904 by Matilda W. Bruce. The Mineral Collection which thus attained a high standard of merit has been augmented year by year through careful selection of the best available specimens of the more recently discovered species, varieties and occurrences. The more newly acquired of these will be found in the small cases of Recent Accessions displayed at the entrance of the Hall.

CLASSIFICATION OF MINERALS

A mineral is a natural chemical compound, that is, it has in most instances a definite chemical composition, and it is this chemical composition, constituting as it does the essential and unvarying characteristic of a mineral, which forms the basis of its classification. There are many thousands of compounds known to chemists which include the 800 or more *natural* compounds, or minerals. But all of these when reduced to their simplest constituents are proved to be made up from combinations of a relatively small group of ultimate substances called elements. Of the 80 or more elements at present known, there are 20 which are so common that they make up 99½ percent of the surface layer of the earth's crust to a depth of 10 miles, which marks the limit of our knowledge, and of these 20 only 8 are needed to constitute 97 percent of this surface layer. The 20 commonest elements in the order of their abundance are:

1.	Oxygen	O	5.	Calcium	Ca
2.	Silicon	Si	6.	Potassium	K
3.	Aluminum	Al	7.	Sodium	Na
4.	Iron	Fe	8.	Magnesium	Mg
These constitute 97 per cent					
9.	Titanium	Ti	15.	Manganese	Mn
10.	Hydrogen	H	16.	Chlorine	Cl
11.	Carbon	C	17.	Strontium	Sr
12.	Phosphorus	P	18.	Fluorine	Fl
13.	Sulphur	S	19.	Zirconium	Zr
14.	Barium	Ba	20.	Nickel	Ni

In order to understand better the chemical system used as a basis for classifying minerals, it is more convenient to group these 20 common elements into two classes, metals and non-metals.

Metals. Aluminum, Iron, Calcium, Potassium, Sodium, Magnesium, Titanium, Barium, Manganese, Strontium, Zirconium, and Nickel.

Non-metals. Oxygen, Silicon, Hydrogen, Carbon, Phosphorus, Sulphur, Chlorine and Fluorine.

It is this last series of the non-metals which is especially important to remember, because in the combinations of one or more non-metals with one or more metals which, in general, go to form minerals it is the non-metals which determine in what class the mineral is to be placed. So we have for some of the principal divisions of the classification of minerals:

Sulphides, composed of sulphur and some one or more of the metals, as sulphide of copper, the mineral Chalcocite.

Chlorides, composed of chlorine and a metal, as chloride of sodium, the mineral Halite.

Oxides, composed of oxygen combined with some of the metals, as oxide of iron, Hematite.

The oxides of the metals, which have different properties from the uncombined metals, sometimes combine with the oxides of the non-metals and form more complex compounds which are called oxygen salts and constitute important divisions of the mineral classification. Some of these are the Carbonates, the Silicates, the Phosphates, the Sulphates, etc.

NAMES OF MINERALS

It is a general rule in the natural sciences, such as Botany and Zoology, to preserve in the name of a plant or animal either some word of Latin or Greek origin (because these are at present the universal languages of science) which describes a characteristic of the species, or to perpetuate in naming it the surname of some distinguished man connected with its discovery. This very general rule has been applied to the naming of minerals and the termination *ite* or *lite*[1] is almost always added. For example, Hematite is named from the Greek word for blood because its common varieties are red in color; Haüynite is named after

[1]Originally from λίθος, a stone.

the French crystallographer Haüy, and Andalusite is named from the ancient province Andalusia, in the South of Spain, where it was first found. This last name is an example of the practice of naming some minerals after the place where they were discovered. Some mineral names which do not end in *ite* are survivals of a time when the science was in its infancy and recognized few species. Many of these, as Quartz, Garnet, Gypsum, Corundum and Spinel, are so old and well established that they have come down to us unchanged.

GUIDE TO THE COLLECTION

The collection of minerals displayed in the Morgan Hall of Minerals is without question one of the finest to be found in the world. Although remarkably complete in its representation of most of the mineral species known to science, this collection is especially noteworthy for its assemblage of splendid examples of the commoner and more widely distributed minerals.

The visitor should begin with the first of the table cases to the left of the entrance and proceed from left to right along each side of every case throughout the series, advancing from east to west along the south side, crossing to the north side at the west end of the hall and following the numbering of the cases back to the east entrance. Each case is furnished with a descriptive label referring to its contents and indicating the high case of the series, arranged down the center of the hall and along the south wall, which contains large and handsome specimens of the same species. These latter are placed in close proximity to the corresponding table cases of the principal series and can be readily located.

ELEMENTS

Cases A and 1

This small but important division of the mineral classification includes those elements which occur in nature uncombined, or in a "native" state, as native gold and native bismuth. Chemically they are the simplest of all minerals and consequently the best with which to begin the inspection of a series which increases in chemical complexity as it develops.

STIBNITE FROM ICHINOKAWA MINE, IYO JAPAN
A group of slender prismatic crystals

Two kinds of native carbon, diamond and graphite, will be found in Case A. These are widely different in appearance and properties and illustrate the way in which, under different conditions of formation, the same chemical substance may yield dissimilar modifications. The beautiful groups of yellow sulphur crystals furnish the first glimpse of

PYRITE FROM CENTRAL CITY, COLORADO
Group of cubic crystals

the wonderful intricacy and symmetry of the crystal forms of minerals (compare with model in Case M). Sulphur is formed near active or extinct volcanoes and in the beds of gypsum, where it constitutes a decomposition product. The native metals are represented by gold in nuggets, veins and crystal aggregates, silver in wire-like and branching

forms, and copper in beautifully developed crystals and crystal masses, presenting a great variety of shapes. All these are readily recognizable in luster and color from our association of them with coins, jewelry and other familiar things.

SULPHIDES

Cases 1, 2, B and 3

The Sulphides which are here made to include the Sulpho-Salts are compounds of sulphur with the metallic elements. They are the characteristic minerals of the metallic veins from which the greater part of the more valuable metals are derived. In these veins, which were originally fissures or clefts in the rocks, vapors and fluid solutions highly charged with sulphur and with dissolved metals deposited their contents in the form of sulphides. The openings in this way ultimately became filled or partly filled with these minerals, which are called ores, together with associated unproductive minerals, such as quartz, calcite, and fluorite, which are known as gangue minerals. The finest and most characteristic specimens come from the parts of the veins which have not been completely filled in the process of formation and in which the crystallized minerals have had a chance to separate individually. This is illustrated by the handsome groups of stibnite crystals in long slender prisms (Case 1), the varied series of galena, sphalerite and chalcopyrite specimens (Case 2), the wide range of pyrite specimens, showing many complex and highly modified crystals (Case B), and the exceptionally fine series of proustite, pyrargyrite, tetrahedrite and enargite (Case 3). This division also includes many rarer minerals in notable specimens, such as ullmannite, sylvanite, emplectite, binnite, cosalite, bournonite, jordanite and stephanite.

HALOIDS

Cases 3 and 4

This division of minerals includes the compounds of the metals with elements of the chlorine groups, the latter being known as halogen elements and comprising chlorine, bromine, iodine and fluorine. These give the chemical compounds called chlorides, bromides, iodides and fluorides.

Some of the haloids, as exemplified by the mineral halite or rock salt, the chloride of sodium, occur in nature in extensive beds and have been deposited by evaporation from bodies of water which have in times past been cut off from the main body of the ocean. The series of halite specimens in Case 3 includes many striking examples of large and well-developed crystals.

MARCASITE FROM FELSOBANYA, HUNGARY
A radiated aggregate of flat crystals

The most widely distributed mineral in this division is fluorite, the fluoride of calcium. This is essentially a vein mineral and is frequently found associated with the sulphide ores of lead and zinc. The large cubic and octahedral crystals of fluorite from all parts of the world

shown in Cases 3 and 4, illustrate the very great variation in color which is a chracteristic of this mineral and which is due to the presence of a slight amount of such impurities as iron and manganese. Many of the fluorite specimens show bandings of color produced by slight changes in the composition of the mineral-forming solution. Among the oxychlorides in Case 4 will be found some beautiful examples of the rare copper minerals boleite and percylite.

FLUORITE ON SMOKY QUARTZ FROM GRIMSEL, SWITZERLAND

OXIDES

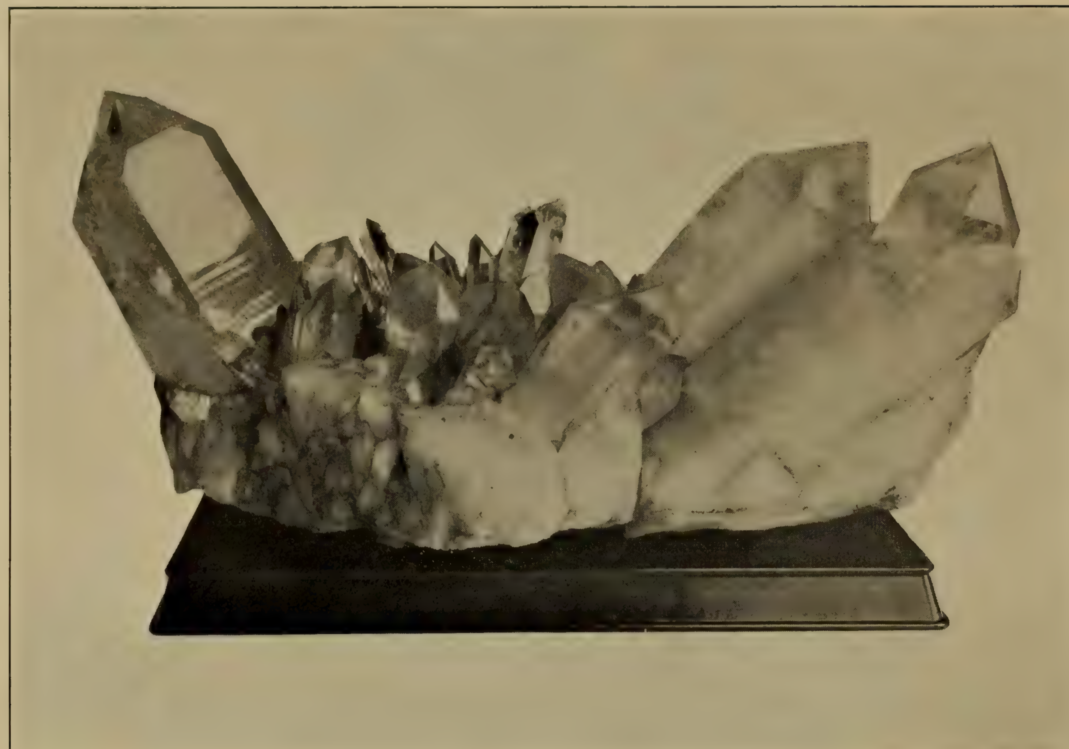
Cases 4, C, 5, 6, D and 7

Oxygen, one of the most energetic of the elements, also constitutes a large part of the atmosphere of the earth, and of water which is almost universally present on it. Consequently, as we would expect, the oxides, or compounds of oxygen with the metals, form a large and important division of minerals. But the element silicon ranks next to oxygen in abundance and combines readily with it. It is therefore quite obvious that the mineral quartz, which is the oxide of silicon, should be the commonest and most widely distributed of all minerals.

The suite of quartz specimens beginning in Case 4 is exceptionally fine. At the head of the series will be found the sharply defined, brilliant, transparent crystals which are familiar to most of us. These are characteristically six-sided with prisms of varying length and occur as single crystals or in groups. In addition to the specimens showing the wide range of crystal habit, attention is particularly directed to the examples of phantom quartz and capped quartz, which illustrate the effect of a change in, or the temporary arresting of the action of the silica-depositing solution, the result in both cases being the production of a quartz crystal around a similar and previously formed one. Small amounts of such impurities as titanium, manganese and organic matter produce respectively the colored varieties, amethyst, rose quartz and smoky quartz (Case C).

There are also many examples of quartz enclosing other minerals, such as sagenite, enclosing slender needles of rutile, and cat's-eye quartz, in which the silica solution has surrounded and imprisoned hair-like fibres of asbestos. The massive forms of quartz (Case 5) are distinguished by their entire lack of outward evidences of crystallization. Here the mineral assumes rounded outlines, similar to and produced in much the same way as the icicles of frozen water or the stalactitic deposits which are formed by the dripping of mineral solutions in a cavern. Beginning with chalcedony, which well illustrates the deposit of quartz from a silica solution of uniform composition, the series shows a great variety of agates, in which the layers of differently colored quartz have been produced by a change in the amount and character of the coloring impurity in the silica-depositing fluid. Considerable amounts of iron and clay give rise to the opaque, massive varieties, jasper and basonite.

Opal is a hydrated oxide of silicon, that is, it has the same chemical composition as quartz except that it contains a varying percentage of water. Among the many varieties of opal in Case 5, the one which appeals most strongly on account of its beauty is precious opal. The brilliant and varied play of color which is a well-known characteristic of this mineral is supposed to be caused by incipient cracks in the mass of the stone. These reflect back the light in the same way as the film of a soap bubble or of oil spread on water. Both massive quartz and opal under favorable conditions replace the woody tissue of trees, produc-



QUARTZ FROM MAGNET COVE, ARKANSAS
A group of transparent crystals

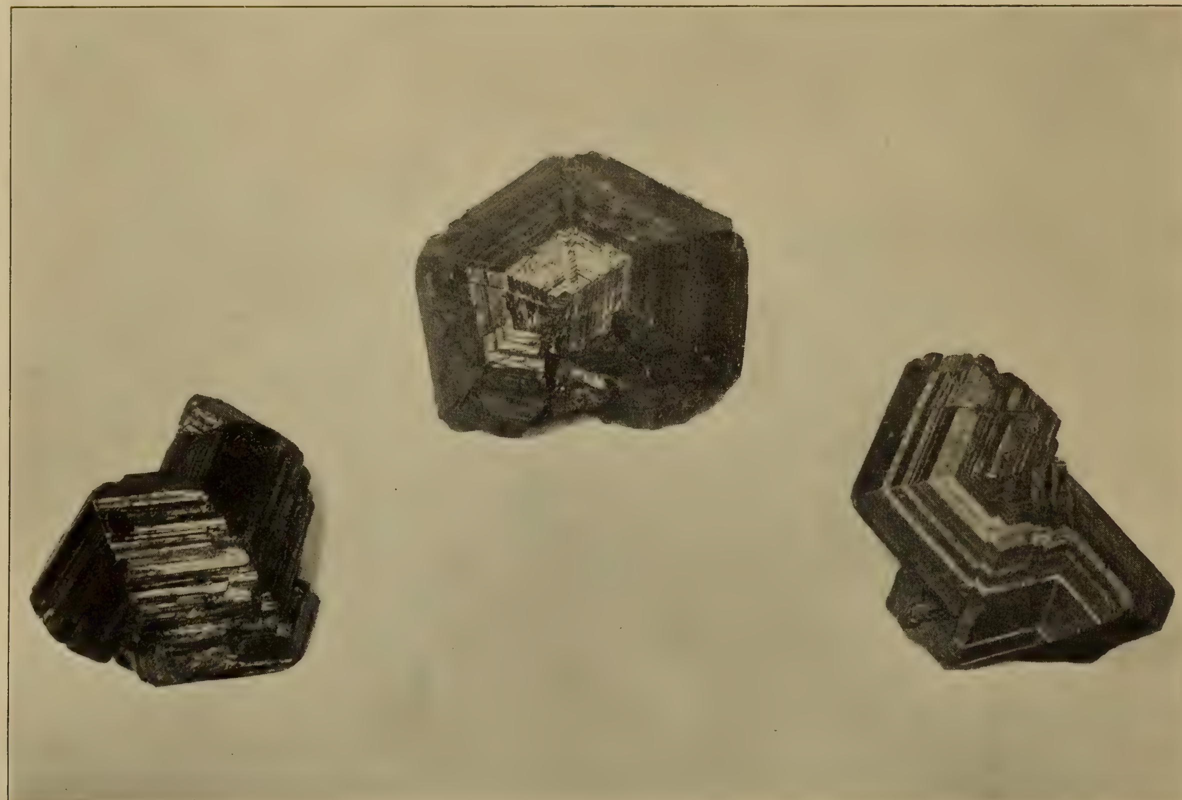
ing jasperized wood and opalized wood. These varieties, when polished, exhibit very strikingly the outlines of the cellular structure of the wood which has thus become petrified.

The metallic oxides are represented by a number of widely distributed and important minerals. The copper oxide, cuprite (Case 5), furnishes some handsome groups of isometric crystals of cubic habit and deep red color.

HEMATITE FROM ST. GOTTHARD, SWITZERLAND
Rosettes of flat crystals

Corundum, the sesquioxide of aluminum, with its richly colored varieties sapphire and ruby, also constitutes a very attractive series. In this instance the crystal forms consist mostly of hexagonal pyramids which are often highly modified.

Hematite (Case 6), the sesquioxide of iron, is the principal source of that metal. The series includes a number of varieties, grading from the brilliant crystal groups from Elba and Switzerland to the massive red, loosely compacted material from the ore beds of Michigan. Mag-



RUTILE FROM PARKESBURG, PA.
Rosettes of knee-jointed, twinned crystals

MANGANITE FROM ILEFELD, HARTZ, GERMANY
A group of crystal aggregates

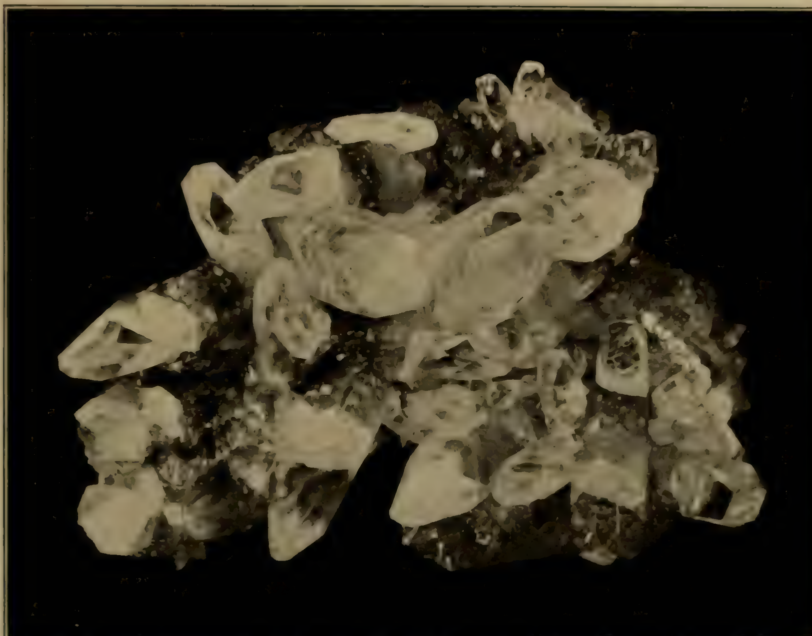
netite is another iron oxide which merits attention because of its importance as a source of iron. Specimens from many of the American and foreign deposits are shown in this series. Cassiterite and rutile are closely related oxides of this group and furnish the visitor with magnificent examples of tetragonal crystals. Many of these are so free from distortion as to be almost diagrammatic in their four-fold symmetry (Compare with models in Case M). Among the hydrous oxides in Case 7 are two minerals to which attention is particularly directed because of their economic importance as ores and because they illustrate in a striking way the characteristic manner in which this class of minerals has been deposited. Limonite, the hydrated oxide of iron, and psilomelane, the hydrated oxide of manganese, give evidence of their secondary origin by a variety of forms both interesting and curious. Here we find iron oxide which has replaced and taken the crystal forms of other iron minerals, rounded masses deposited layer upon layer, and delicate thread-like stalactites of great beauty.

CARBONATES

Cases 7, 8, E and 9.

Among the simplest of the groups of compounds derived from the oxides of the non-metals are the carbonates, which are combinations of carbon dioxide with one or more of the metallic oxides. At the head of this division stands the mineral calcite, important because of its very wide distribution and its common association with minerals of ore veins, and extremely interesting because of the almost infinite variety of form and habit shown by its crystals. There is no finer example to be found among mineral species of the manifold expression of the law of symmetry in crystallization, which in this instance among thousands of complex manifestations preserves a three-fold symmetry. The series of crystallized calcite in Cases 7 and 8 well illustrates the wide range of forms characteristic of this mineral, from the simple rhombohedra from Poretta and the six-sided prisms from Saxony to the highly complex modifications from Cumberland and Michigan.

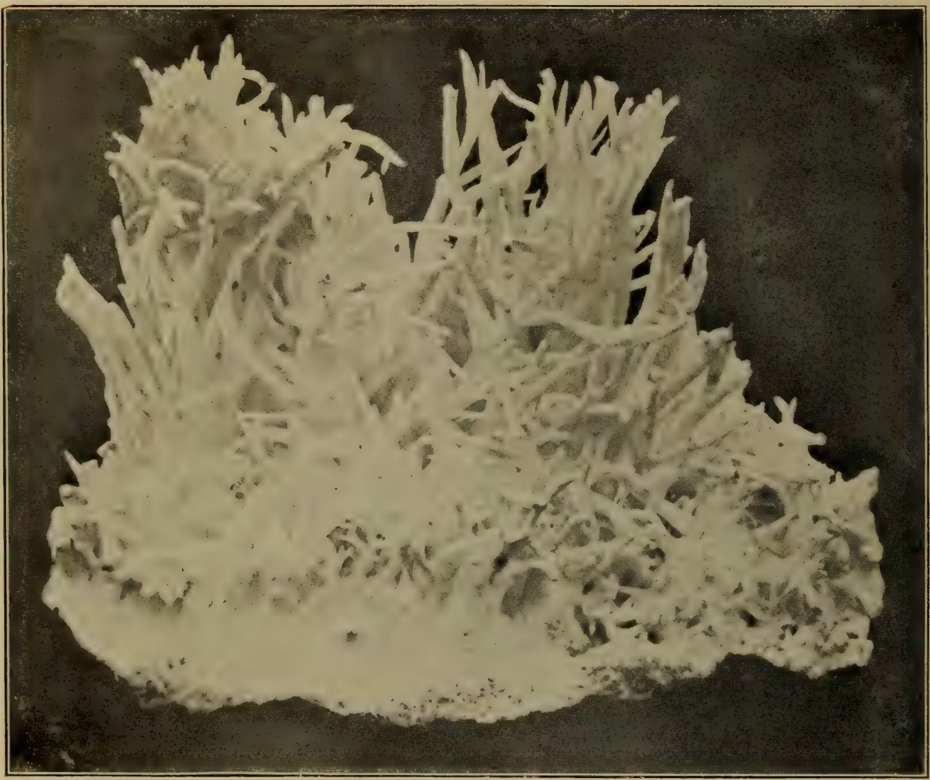
Dolomite, the carbonate of calcium and magnesium; siderite, the carbonate of iron, and rhodochrosite, the carbonate of manganese, all belong in the same group with calcite and have many of the characteristics of form which were seen in that mineral. They are best



CALCITE FROM CUMBERLAND, ENGLAND
A group of highly modified crystals

CALCITE FROM EGREMONT, ENGLAND
Twinned crystals

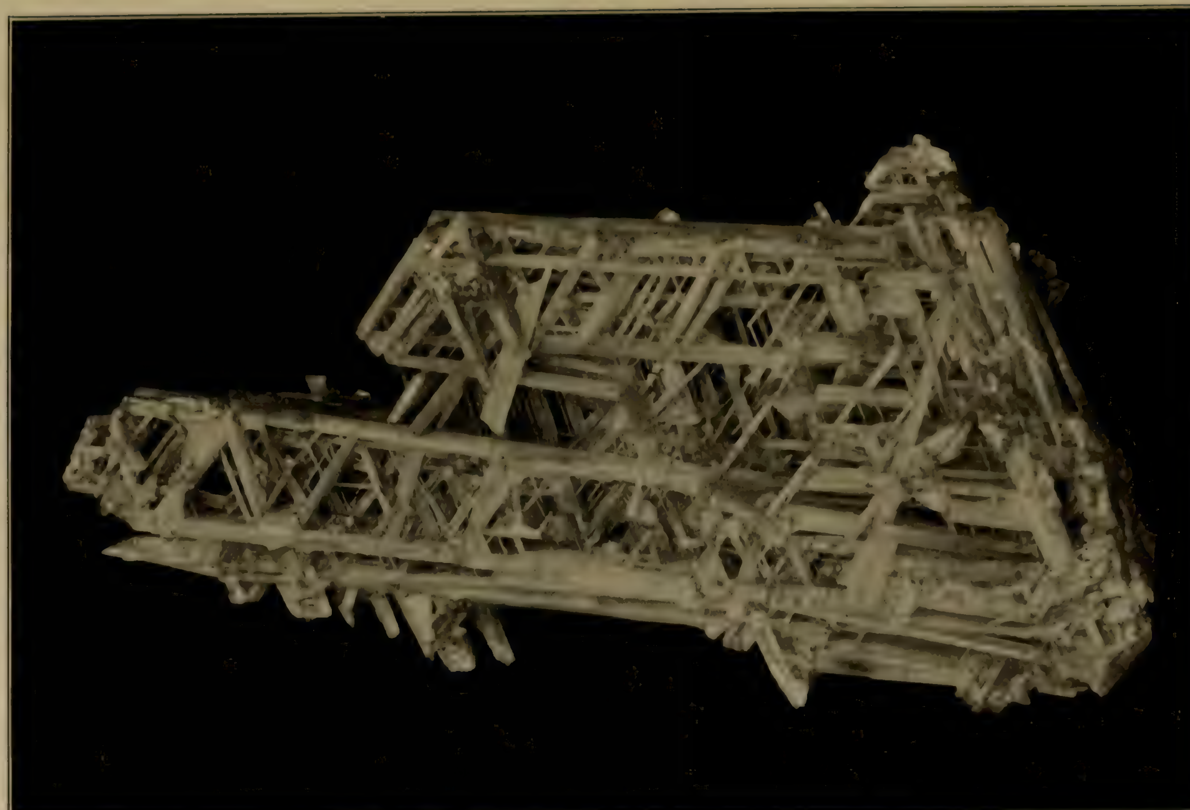
distinguished from calcite by the fact that they unite in curved groupings and by their differences of color. The series of siderite and rhodochrosite in Case E is especially fine. Aragonite is a second form of calcium carbonate and one which crystallizes in an entirely different way from calcite. Among the suite in Case 9, attention is particularly



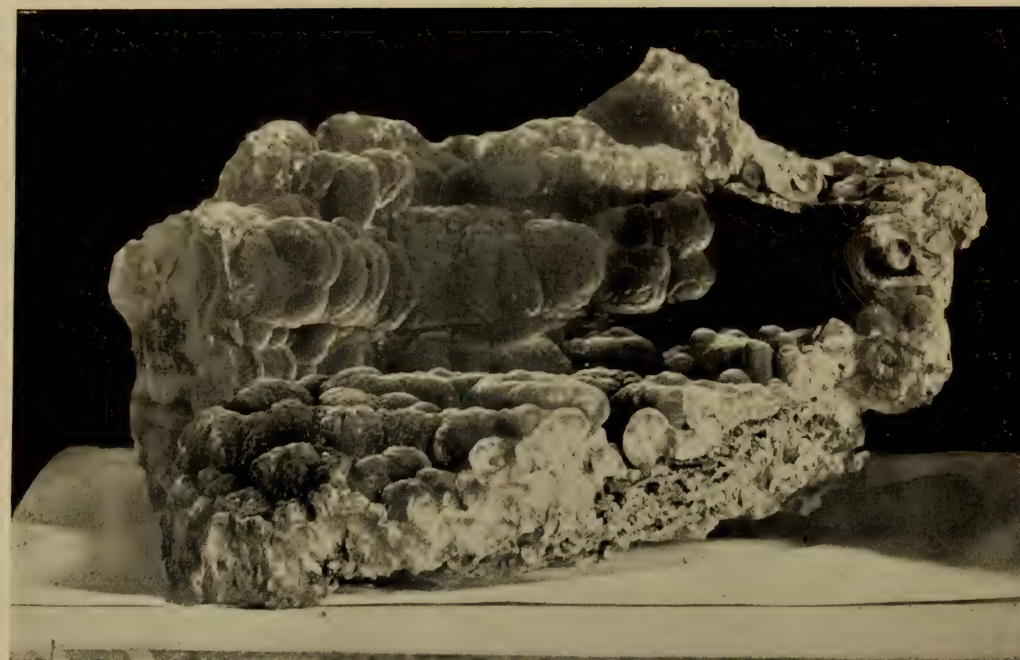
ARAGONITE FROM STEIERMARK, AUSTRIA
"Flos-ferri" in stalactitic shapes

directed to the branching coral-like forms which distinguish the cave deposits of aragonite and which, with their delicate lace-work of fine stalactitic stems, constitute objects of great attractiveness of form.

Cerussite, the carbonate of lead, is related to aragonite in much the same way that the minerals of the group containing dolomite, siderite,



CERUSSITE FROM BROKEN HILL, NEW SOUTH WALES
Cluster of interlaced, fibrous crystals



MALACHITE FROM BISBEE, ARIZONA
A velvety, stalactitic mass

and rhodochrosite are related to calcite; cerussite is mainly formed by the alteration of galena through the action of water charged with carbon dioxide.

The two copper carbonates *Malachite* and *Azurite* (Case 9) are attractive by reason of their rich colors and the unique shapes taken by the radiating, silky fibers of the one and the brilliant crystal masses of the other. Like cerussite they are alteration minerals which have resulted from the action of water charged with carbon dioxide on other copper ores.

SILICATES

The largest and from some points of view the most important division of the natural chemical compounds which constitute the minerals is that one which has for its basis the combinations of the two commonest elements, silicon and oxygen. The oxygen salts composed of these two elements combined with the oxides of the metals give us the very numerous and varied groups of rock-forming minerals known as the Silicates.

Broadly speaking the silicates are the minerals of the igneous or fire-formed rocks; they are essential constituents of granites, pegmatites, gabbros, diorites and gneisses, and some of them are to be found in crystalline limestones and as secondary minerals lining the cavities of lava, basalt and diabase.

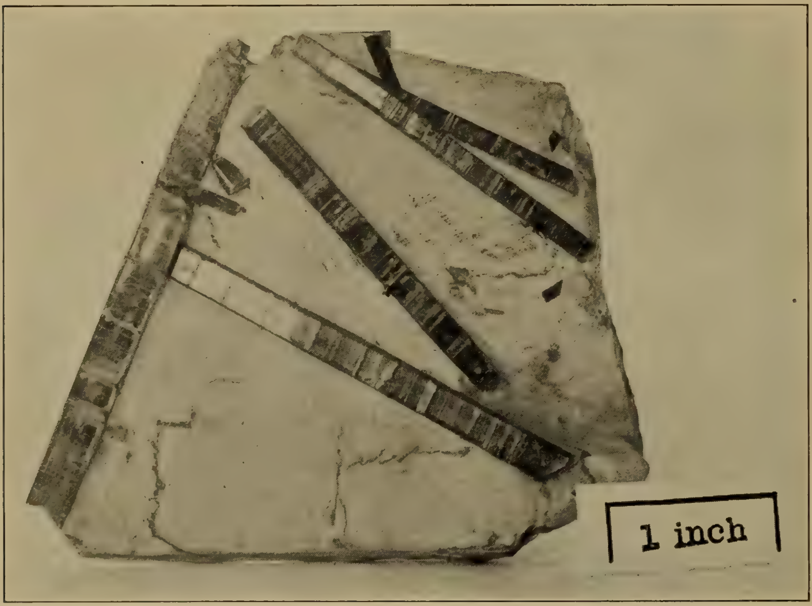
The Feldspars, shown in Case 10, are silicates of aluminum with some other metal. They are the commonest and most widely distributed group of minerals in this division and constitute nearly 60 per cent of the mineral composition of igneous rocks. In the series exhibited, orthoclase, microcline and albite are especially beautiful and interesting, as is also labradorite with its brilliant and varied play of colors.

The Pyroxenes (Case F) form another important group of silicates embracing a number of closely related minerals, all conforming to a characteristic crystal habit. Here may be seen marked differences of color due to variations in chemical composition as well as differences in transparency from the clear gem-like diopside to the opaque black augite.

Rhodonite (Case G) is a triclinic pyroxene containing manganese which gives to it a handsome rose color. The specimens of this suite are especially attractive.

The group of Amphiboles (Case G) constitutes a large and important portion of the silicate division, and like that of the pyroxenes is made up of a number of mineral varieties closely related chemically and based on variations from a standard chemical type.

Beryl is a silicate of the rare metal beryllium which furnishes the two well-known precious stones emerald and aquamarine. The many varieties of this mineral are shown in the splendid series to be found in Cases G and 11, which furnishes one of the most attractive portions of the collection.



CYANITE FROM ST. GOTTHARD, SWITZERLAND
Blade-like crystals in mica schist

Garnet (Case 11) is a common and widely distributed silicate to be found as an accessory mineral in rocks of almost every kind. Occurring in crystals of a simple and very characteristic isometric habit, garnet displays an amazing range of color in its many varieties. The series exhibited is notably large and complete. Among the important silicates in Case 12 will be found willemite, the silicate of zinc, which occurs in several differently colored varieties at Franklin, N. J.; some magnificent

specimens of diopside, the silicate of copper, in well-formed hexagonal crystals; very attractive suites of wernerite, vesuvianite and zircon in single individuals and groups of tetragonal crystals, and crystallized topaz in a diversity of crystal forms and a variety of color as pleasing to the eye as they are interesting.

EPIDOTE FROM TYROL
A radiated group of crystals

Case H contains the silicates epidote, prehnite, axinite and the species of the humite group, all of which are represented by characteristic series well worth close observation and including among the epidotes and axinites some remarkably fine examples.

The suite of tourmaline which nearly fills one side of Case 13 is notable for the richness of its display of this very striking mineral. Both in the foreign occurrences and in those from the United States this portion of the collection abounds in beautiful and unusual mounts. Especially interesting are the specimens showing unequal distribution of color from Haddam, Conn., from Pala, Calif., and from Elba, Italy.

The Zeolite Division of the Hydrous Silicates (Cases 13 and 14) includes some large and finely developed tetragonal crystals of apophyllite in single individuals and in large and imposing groups. Here are also to be found the oddly shaped aggregates of heulandite and stilbite, some of which resemble sheaves of wheat, the scattered groupings of chabazite and analcite crystals which often give the appearance of being strewn over a background of dark rock matrix, and the slender, bunched needles of natrolite, springing from a central nucleus like the rays of a sun. The zeolites are essentially minerals of the basaltic or trap rocks and are mostly to be found in cavities, having been deposited in these cup-like hollows by the evaporation of water solutions.

The Mica Division of the Hydrous Silicates, shown in Case I, include minerals which have the distinguishing property of splitting up into thin elastic plates or sheets, as in the familiar example of white mica or isinglass. Many species and subspecies are to be found in the series displayed, the differentiating characters of which are well shown.

The remaining species of the hydrous silicates are contained in Case 15; a few of the first of these, including clinochlore, strongly resemble the micas in general appearance but split into sheets which are not elastic.

Serpentine is a hydrous silicate of this division which has not as yet been found crystallized, although it often takes the crystal forms of other minerals which it has replaced chemically. Many of these replacements or pseudomorphs are to be found in the exhibited series. A fibrous form of serpentine, called chrysotile, is interesting as furnishing much of the asbestos which is woven into fireproof fabric. Talc and sepiolite are also commercially important minerals, the latter furnishing us with the meerschaum from which smoking utensils are made. Two of the hydrous silicates, garnierite, the silicate of nickel, and chrysocolla, the silicate of copper, are ores of their respective metals.

The last portion of the large class of the silicates includes a number of mineral species containing both silicon and titanium or in some in-

stances titanium acting alone as an acid, the latter compounds being designated as titanates. Chief among these titano-silicates will be found titanite (Case 16) represented by many varieties, some of which are transparent and gem-like and all of which are interesting to the student and the collector. Although not of economic importance, except as a rather rare gem species, titanite has some interest as an accessory rock-forming mineral. In Case 16 will also be found the compounds of the rare elements niobium and tantalum known as columbates and tantalates. These include columbite and samarskite as well as a considerable number of rarer minerals, all of which are very useful as the sources of the group of rare elements such as yttrium, cerium, lanthanium, didyium, etc., which are daily becoming more important commercially.

PHOSPHATES

Cases 16, J, 17 and 18

The Phosphates, which also include the somewhat rarer arsenates, vanadates and antimonates, comprise a considerable and very varied group of minerals. Xenotine and monazite are somewhat related commercially to the columbates and tantalates of the preceding group because they are phosphates of the rare elements previously mentioned. Case 16 contains a very complete series of these. The common mineral apatite (Cases 16 and J) is essentially a phosphate of lime and is the most widely distributed of all the phosphates. As is the case with most of the common mineral species, apatite is found in a great many varieties; these differ in color and transparency, but all when crystallized exhibit the characteristic six-sided prism capped by a low pyramid or by a flat base. The large series exhibited shows well the varied difference in form and color of this mineral as well as its almost universal distribution. Pyromorphite and mimetite (Case J) are respectively the phosphate and arsenate of lead with lead chloride. Both are alteration products occurring in the oxidized portions of lead sulphide deposits, and the commoner of the two, pyromorphite, is ranked as an ore of lead. The brilliant color and unique crystal aggregates to be found in the series of specimens exhibited render these minerals objects of considerable attractiveness.

Vanadinite (Case 17) is the vanadate of lead and bears the same relation to the more commercially important deposits of lead sulphide as do pyromorphite and mimetite. In the series displayed attention is

drawn to the beautifully developed hexagonal crystals and the rich and striking colors shown in this handsome suite of specimens. Among the rarer phosphates in Case 17 will be found many minerals which by reason of their beauty and interest will well repay a short inspection. Among these may be mentioned descloizite, the lead-zinc vanadate; libethenite and pseudomalachite, the rare copper phosphates; roselite and erythrite, arsenates of cobalt, and variscite, a phosphate of aluminum.

Wavellite (Case 18), another phosphate of aluminum, presents many striking examples of radiating and stalactitic structure combined with colors of choice delicacy and attractiveness. Turquoise, the familiar gem mineral, here takes its place among the phosphates and is represented by a fine series of matrix specimens which illustrates its distribution as well as its slight color variations. The radioactive minerals torbanite, copper uranium phosphate, and autunite, the calcium uranium phosphate, are represented by many specimens, which in the instance of autunite give evidence to the unaided eye, by the singular quality of their yellow green color, of the unusual character of their emanations.

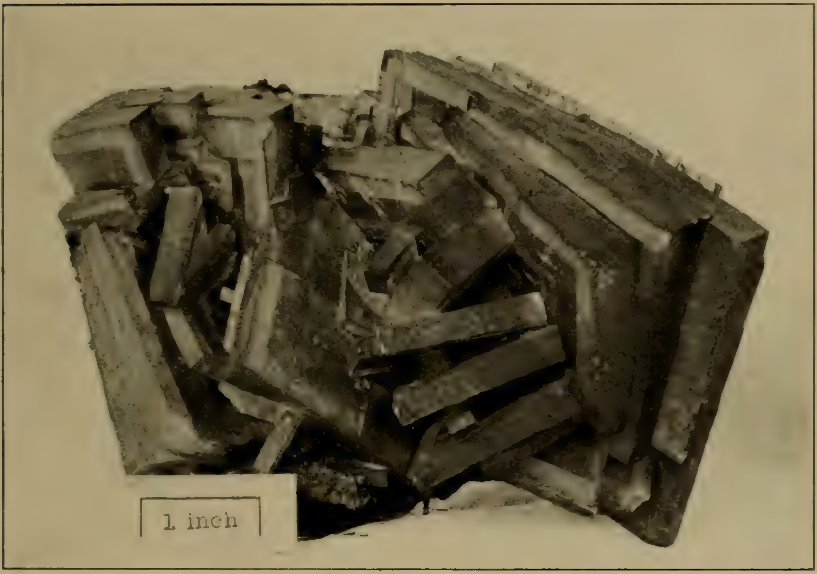
Among the borates in Case 18 will be found a remarkably handsome and complete suite of colemanite, a calcium borate from California. Case 18 also contains the radium minerals uraninite, gummite and carnotite. Of these, uraninite contains the higher percentage of radium, but carnotite, owing to its wider distribution in the Western United States, is becoming the more important radium ore.

SULPHATES

Cases 18, 19, K and 20

Like the phosphates, the minerals of the Sulphate Division are mostly secondary products which have been derived from other minerals or rocks by alteration. The action of water upon most of the sulphides of the metals produces from these sulphuric acid and metallic oxides, which combine to form sulphates. Many of these sulphates are soluble in water and are consequently carried away in solution to be deposited elsewhere, but the larger number of them are to be found in more or less close proximity to the primary minerals from which they were derived.

Barite, the sulphate of barium, is a common and widely distributed mineral species, frequently found in association with metallic ores as a vein mineral. In the series exhibited in Cases 18 and 19 many examples of the occurrence of barite with sulphides of lead, copper, iron and silver will be found. Like calcite, barite is remarkable for the great diversity and complexity of the crystals in which it forms; splendid specimens of these orthorhombic crystals are shown throughout the suite which is both very complete and of notably high quality. Closely



BARITE FROM FRIZINGTON, ENGLAND
An aggregate of flat prismatic crystals

related to barite is the sulphate of strontium, celestite. Although sometimes occurring like barite with metallic ores, celestite is more often found in close association with sulphur and gypsum; an example of the latter association is found in the specimens from Girgenti, Sicily, a magnificent series of which will be found in Case 19. Celestite furnishes the strontium salts which are much used in the manufacture of fireworks, in medicines and in refining sugar.

Anglesite (Case 19) is another sulphate which has an economic importance. This lead mineral is frequently found associated with

galena as a decomposition product of the latter and is often mined with it and other ores.

A very striking and beautiful series in Case 19 is that which represents the mineral crocoite, the lead chromate. The bright hyacinth red and orange color, which constitutes one of the chief characteristics of this mineral, is affected by long exposure to the light and consequently the suite of specimens is covered with a black cloth which should be removed in order to view this exhibit. One of the most common and important of the sulphates is gypsum (Case 19), the hydrous sulphate of calcium. The exhibited suite of specimens is remarkable for the size and quality of its crystallized examples both as single individuals and in large groups. Among the rarer species which are included among the hydrous sulphates are many specimens which combine great beauty of color with interesting structure, features which tend to make this one of the most attractive sections of the collection.

TUNGSTATES, MOLYBDATES

Although represented by very few minerals, this division of the classification contains three important species, wolframite the tungstate of iron and manganese, scheelite the tungstate of calcium, and wulfenite the molybdate of lead. These are all important minerals from a commercial point of view, because they furnish us with the rare metals tungsten and molybdenum which are used to make special steels of a high grade of strength and durability. The series which includes these three, as well as many rarer tungstates and molybdates, will be found in Case 20.

THE MINERALS OF MANHATTAN ISLAND

Manhattan Island offers the somewhat unique case of a limited area of mineral-producing rocks where excavations have been carried forward to such an extent that practically all of the crystalline rocks which underlie the drift deposits have been exposed at some time, and most of this area has been laid bare within a fairly recent stage in the development of the City. As a consequence of this unusual activity in excavation, much is known concerning the minerals which occur in the local rock formations, and the local collections made from these rocks

have been both exhaustive and varied. Much of the credit for this intelligent activity in collecting and preserving the local minerals belongs to the members of the New York Mineralogical Club, the results of whose labors in this field may be seen in the Collection of Manhattan Island Minerals, loaned through the courtesy of the New York Mineralogical Club and displayed in Case 27. Practically every species of the long list recorded from Manhattan Island is included in this series, which is not only large and representative, but contains many specimens of a quality which renders them noteworthy apart from their unusual local interest. Among these latter are especially fine examples of smoky quartz, chrysoberyl, calcite, orthoclase, oligoclase, albite, beryl, garnet, dumortierite, cyanite, tourmaline, stilbite, chabazite, harmotome, muscovite, titanite, xenotime, monazite, etc.

BOOKS

Very few books of a popular nature have been published on the subject of Mineralogy. In addition to the "Popular Guide to Minerals" by L. P. Gratacap, mentioned in the note at the beginning of this *Leaflet*, the following books may be read with profit by a beginner in the study of mineralogy.

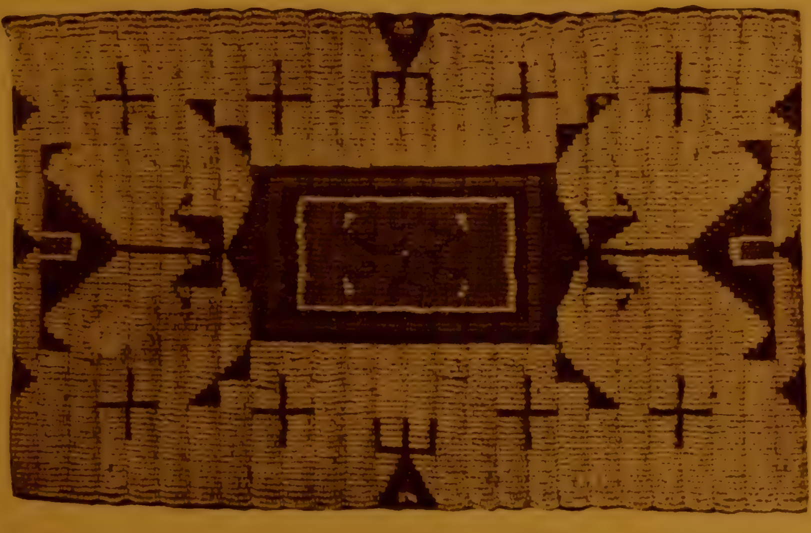
> "Minerals and How to Study Them," by Edward Salisbury Dana. John Wiley and Sons, 1895.
>
> "The World's Minerals," by Leonard J. Spencer. Frederick A. Stokes Company, 1911.

Although there is much to be gained by the student of mineralogy from books, and although they furnish a very necessary key to the meaning of what is to be seen in the mineral world, the best and most satisfactory knowledge of the subject is to be gained from studying collections of minerals. The knowledge which enables one to recognize a mineral at sight is similar to the knowledge which enables one to recognize a friend. It is a composite realization of a number of characteristics, no one of which is sufficiently definite and unique to be relied on without the aid of some of the others. We may read a statement of the form, the color, the luster and the various other attributes of a certain mineral, but until we have these combined properties set before our eyes in a specimen of that mineral we can form only an imperfect idea of it.

AMERICAN MUSEUM OF NATURAL HISTORY

INDIAN BEADWORK

A HELP FOR STUDENTS OF DESIGN



By CLARK WISSLER

GUIDE LEAFLET No. 50

A bag of woven beadwork—Winnebago

INDIAN BEADWORK

By CLARK WISSLER
Curator of Anthropology

GUIDE LEAFLET No. 50
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INDIAN BEADWORK

INTRODUCTION

The most famous beadwork is that of the American Indian; in fact, no other people produce anything like it. But not all Indians produce it. The great beadwork area is the country around the Great Lakes and the Western Plains—all the States that border the Lakes, that lie between the Rocky Mountains and the Mississippi, and adjoining parts of Canada.

Beadwork is modern, that is, it originated with the introduction of glass beads after the discovery of America in 1492. Yet there was something like it before, known as porcupine quill embroidery. The latter was prehistoric and wrought in designs similar to those now seen in beads. What happened then was the substitution of European-made glass beads for quills. Thus, the truth of the matter is, that it is the glass beads that are modern and not the art of embroidery nor the designs employed. In fact some quillwork is made to this day. So we are now to study an art that was fully grown when Columbus sailed from Spain in 1492 and one which is the outgrowth of years and years of toil on the part of prehistoric Indian women.

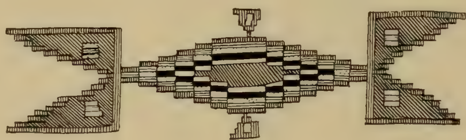
It will be necessary, therefore, for us to study both bead and quillwork. Of beadwork there are two kinds: (a) true embroidery and (b) weaving. The former was almost universal until twenty years ago. All of the examples on exhibition in the Plains Indian and the Southwest halls of the Museum, are of this type. In the Woodland Hall, on the other hand, both embroidery and weaving appear, particularly among the Menomini tribe.

GUIDE TO THE COLLECTIONS.

Bead and quillwork are shown in three halls on the ground floor. Turn to your left from the main entrance to the Museum, into the hall for the Indians of Eastern United States (Eastern Woodland Hall). The best bead workers represented in this hall are the Ojibway, Menomini, Sauk and Fox, and Winnebago, all living near the Mississippi. But the center of the art is west of the Mississippi among the Plains Indians, collections for which are in the next hall, west. Almost every case in that hall is a storehouse of beaded designs. Then to your right,

just within the hall for the Indians of the Southwest, are some additional examples.

Quillwork may be found among the beaded objects in the Plains Indian Hall, where both quills and beads sometimes occur on the same object, especially in the Dakota, Cheyenne, Assiniboin, and Blackfoot collections. In the Woodland Hall ordinary quillwork occurs among the Menomini collections, while woven quillwork, one of the most interesting techniques, is shown in the wall cases marked Mackenzie Area. Finally, a small amount of bead and quillwork is shown in the Jesup North Pacific Hall, north from the main entrance.



BEAD EMBROIDERY.

Originally all bead embroidery was upon skin, but later cloth was substituted. In general there is but one process: the beads are strung upon a thread and this is sewed down to the skin (Fig. 1). The arrangement of these threads is determined by the style of design: when the design is geometric, the threads are laid on parallel, not unlike the weft elements in a loom; but when flowered and other curved designs are attempted, the figures are built up by following the contour desired, or each unit of the design is formed independently. This can be seen in the illustrations. Sometimes floral designs are first embroidered in their proper position; then the background is filled out by laying the beads down in horizontal rows (Fig. 17).

Some of the tribes using the straight parallel method, sew down the strings of beads at regular intervals, giving their work a banded, or ridged appearance (Fig. 2) in contrast to the uniform surface of that sewed at irregular intervals.

In this case the design is built up by laying down one of these bands at a time, the uniform width kept by taking the same number of beads for each string. Ten and twelve are the usual numbers, resulting in a band about ½ inch wide. These bands and their bead units are also the main measuring units in laying out the design, as a little study of the specimens will show.

The explanation for this banded beadwork is found in the original quillwork. The technique of that process is described in another part of this booklet. Quills were not strung like beads but were dyed in assorted colors, then flattened out and laid on in bands of uniform width and color. Thus a given band of color followed the contour of the design, whether curved or straight (Fig. 3). In any case, the uniform bands gave a lined, or ribbed surface. This is just what we find in some beadwork, though the beads are strung and handled in a different way from quills. The Indian woman merely substituted beads into the old quill pattern.

On the other hand, the bead embroidery of the Ojibway seems to have had a different history. The earliest known form was the outlining of designs in beads (Fig. 4). Many beautiful patterns produced in this way are to be seen in the Woodland Hall (Fig. 18). According to tradition this was followed by filled-in patterns as in Fig. 17 and finally by full beaded backgrounds where the whole surface is covered. It is probable that this form also originated in a quill technique, for the older forms of quillwork among the Woodland Indians seem to have been outline designs on birchbark, some examples of which are on exhibition.

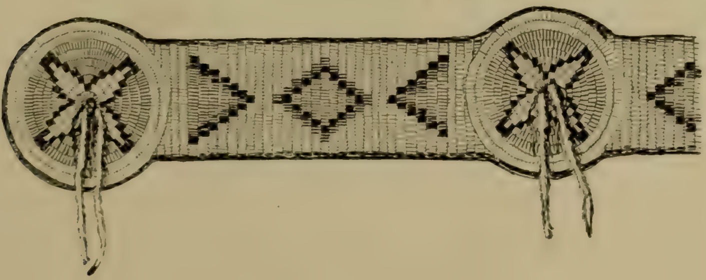


Fig. 1. A Moccasin Upper in Process of Beading.

The uppers of moccasins are beaded before they are sewed to the soles. This piece was secured from an Assiniboin woman to show how the beads are laid on in constructing a design. The outer border is built up by two bands, seven beads wide; between these, over the toe, thestrings of beads are laid on parallel. The colors are: ground in border, pale green; ground in toe, bluish green; figures in blue, yellow ruby, orange. Specimen may be seen in the Assiniboin case, Plains Indian Hall.
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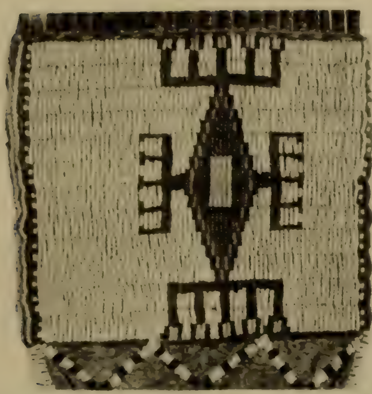
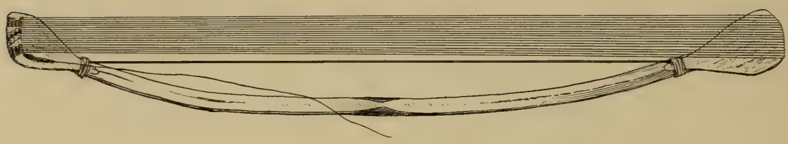


Fig. 2. Bead embroidery in bands resembling quillwork.

Fig. 3. An example of quill embroidery.

Fig. 4. Leggings embroidered with outlines in beads. See Ojibway Collection.



a

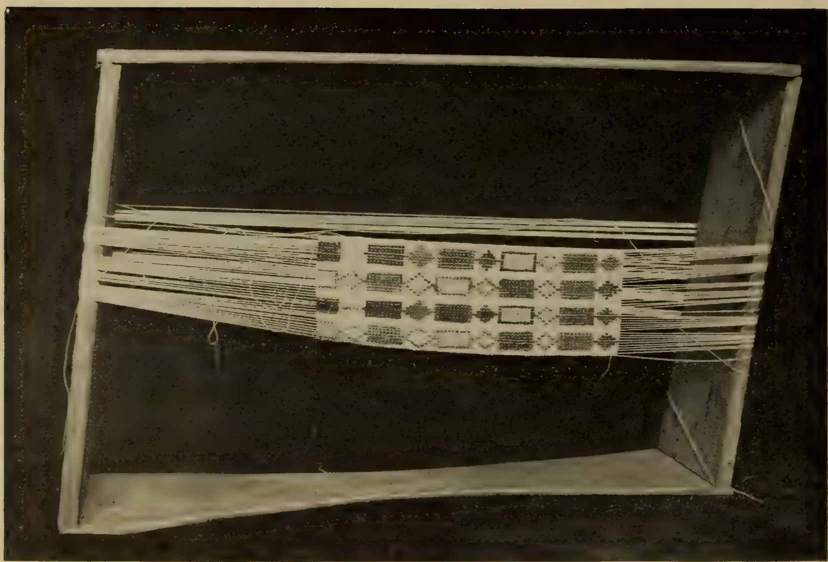


Fig. 5. Weaving Frames.

(a) A weaving bow. This is no doubt an old and original method of bead weaving that still survives in the form shown here. Quill bands (Fig. 10), the forerunners of beaded bands, are woven on similar bows.

(b) A bead weaving frame. The warp threads are wrapped around the frame to the desired breadth of girdle or band. Weaving then proceeds as in Fig. 8a or 8b, until a band of the desired length is obtained, when the warp threads are cut and trimmed into end fringes.

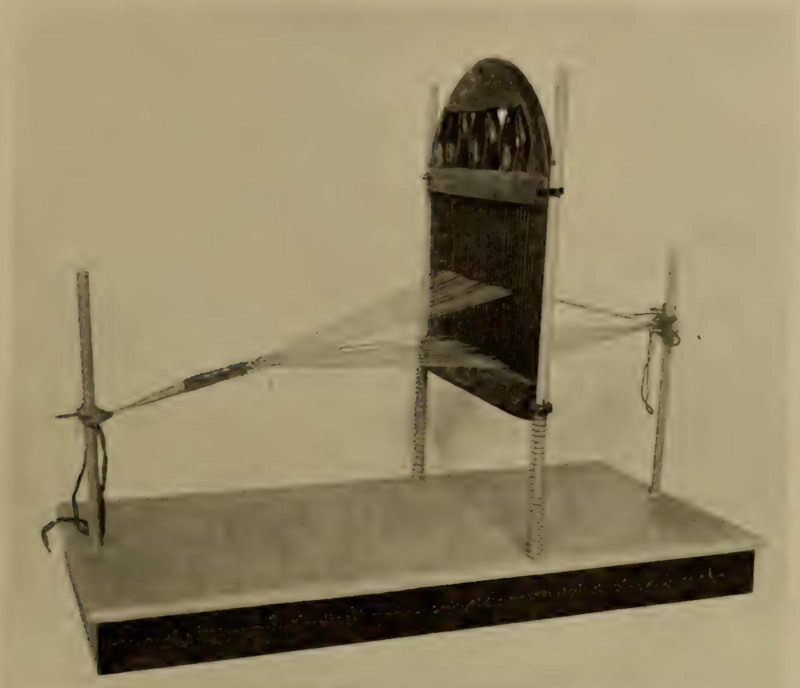


Fig. 6. An unfinished beaded band with wooden heddle.

This is shown as mounted in the Museum case, but in use there are no supporting parts, only the heddle and the threads. One end of the warp is made fast to any convenient object and the other to the belt of the weaver, who can thus hold the warp tight as the heddle is manipulated. There is reason to believe that this heddle is of French Colonial origin and so not an invention of the Indian. See Sauk and Fox collection.

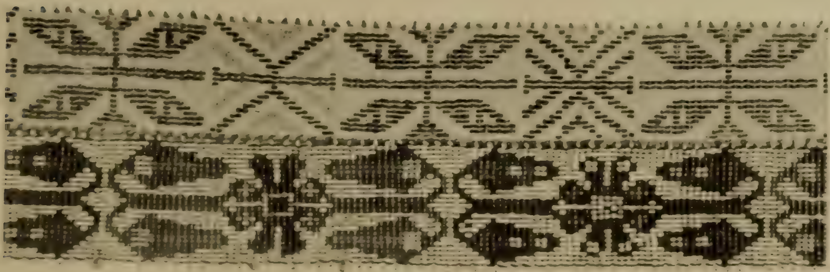
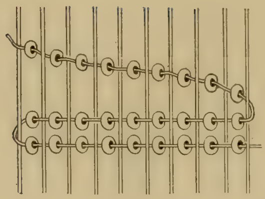


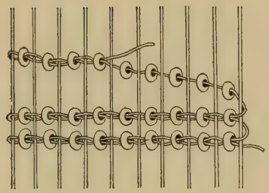
Fig. 7. Part of a beaded garter woven with a heddle similar to Fig. 6.

Fig. 8. Types of Bead Weaving.



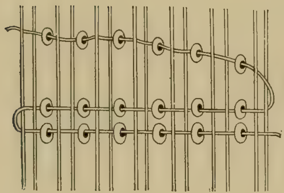
a

(a) Single weft bead weaving. After the warp threads are stretched, a single thread, with needle, is passed through as shown.



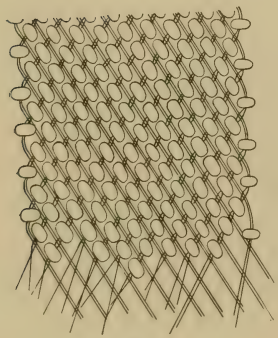
b

(b) Double weft bead weaving. In this case the thread is passed through the beads simultaneously and then laid upon the warp after which the needle is passed back through each bead on the other side of the warp.



c

(c) Double warp. Here the warp is often manipulated by a heddle as in Fig. 6. The weft thread is strung with the correct number of beads and then passed between the warp and the beads properly spaced; the whole procedure is as in loom weaving.



d

(d) Weaving with diagonal threads, a form frequently used in long narrow bands.

BEAD WEAVING.

This type of beadwork is now popular and spreading rapidly among the Indians and our own people. Its center of development seems to have been the Menomini Indians of Wisconsin. A weaving frame of some kind is necessary. Scarfs, garters, and belts are almost invariably the objects made by this process. Strong thread is wound around the frame like the warp in a loom. (Fig. 5). Cross threads (weft) are woven into these and it is upon these that the beads are strung. Menomini specimens show three types of weaving: (a) single weft, (b) double weft, and (c) heddle woven; *a* and *b* are woven on a frame without other help than a needle, but *c* requires some additional apparatus. The Sauk and Fox Indians use the heddle shown in Fig. 6.

The Shoshoni frequently use a bow for the frame (Fig. 5a), the elasticity of the bow keeping the threads stretched; but here the warps are not continuous. This bow-loom is interesting because it seems to be the original loom upon which quill weaving was done, for again we find that a quill technique was the parent of bead weaving.

An interesting form of bead weaving is found among the Seminole, Yuchi, and other southern Indian tribes. Handsome belts, girdles, and garters are woven of commercial yarn. The warp and weft are diagonal and on them at intervals are strung beads. In some cases the warp and weft are white threads and the beads laid in in design patches, around which are bands of different colored yarns, all woven together. These make a unique and striking product. But of much greater interest is the use of horsehair in this diagonal weaving, with an entire beaded surface. The fine stiff hairs hold the beads apart and permit the light to pass through, greatly enhancing the value of the composition. The manner of weaving is shown in Fig. 8d. The same technique, but upon thread, is used by all the Woodland tribes for long narrow bands of beadwork and even occurs in some modern beadwork from Central America (Second Floor). The latter have still another variety in which the weft is carried across the warp, V-like, resulting in a band with a central rib.

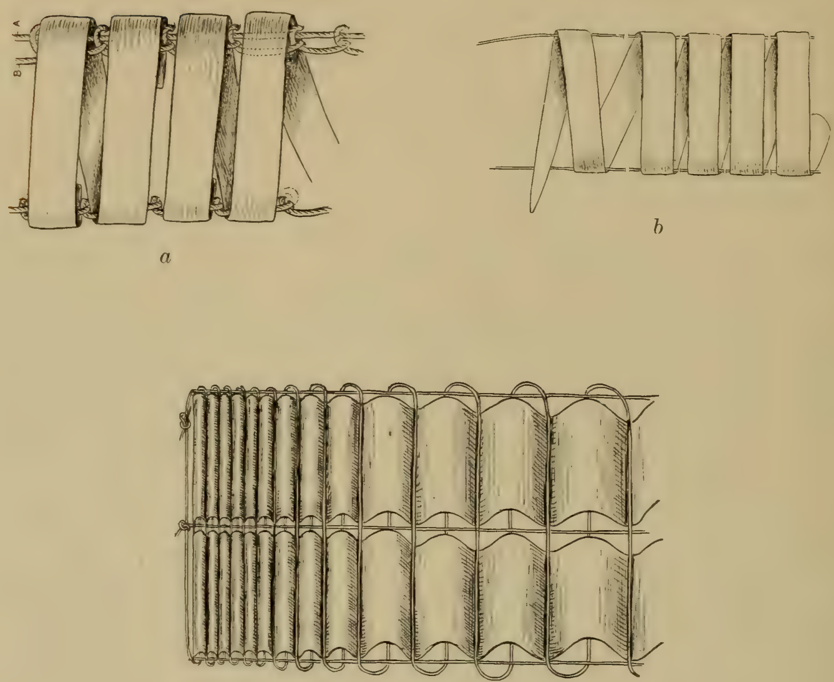


Fig. 9. Technique of Quillwork.

(a) In this technique, the quills are laid on in rows or bands. Designs are worked out by changing the color of the quills. The ends of the quills on the lower edge of a band are held in place by a string of sinew, or thread, *a*, running across the surface of the leather to be decorated, with another thread, *b*, going in the same direction but passing under the first thread through the surface of the leather, back over the first thread and under itself, thus forming a loop between each quill. The thread holding the upper end of the quills in place, is threaded through the surface of the leather in an oblique direction, from left to right (assuming that the work is started from the right hand side) crossing under itself on to the next space between the quills. This is practically the same stitch as that employed for the lower edge, omitting thread *a*.

(b) In this process the surface is similar to that for *a* but the stitch is simple. The thread is passed through the leather and back again between each quill.

(c) Warp threads are strung on a weaving bow; the quills are flattened and passed through the weft, like a ribbon. When the wefts are driven down close, all threads are concealed.

QUILLWORK.

Quillwork seems to have been more widely spread than beadwork; in fact, it was almost universal throughout Canada and eastern and central United States. From remarks of early explorers we infer that quillwork was found among the Indians of Manhattan Island.

The quill of the porcupine is the universal material, though occasionally bird quills were substituted. First the quills were dyed, then flattened, folded to the right length and sewed down by a concealed stitch. These stitches vary a great deal, even in the same tribe. A few of the most common are shown in the figures.

But quills are also used in weaving, as stated. In this case the warp threads of sinew are stretched on a bow, somewhat as in the figure for bead weaving, the flattened quills are passed around the weft and driven up close, resulting in a charming texture. Designs are formed by introducing different colored quills.

If a close study of all the forms of quill and beadwork is made, it will appear that woven quillwork is the parent of all, for the manner of sewing quills down to the skin is such that the relation of quill and thread loops is similar to their relation in the woven quill band. It is difficult to conceive how the curious method of laying these quills in rows and bands could have developed except in imitation of woven quillwork.

While glass beads are modern, there was some bead weaving before 1492. The famous wampum belts were woven. But there were other tribes who cut sections of quills that were treated precisely as the long wampum shell bead by the Iroquois. It is, therefore, a fair assumption that the wampum bead is a development from quills and the wampum belt an outgrowth of quill weaving. There is still a great deal to learn from the study of Indian quill and beadwork to which this little book is but an introduction.

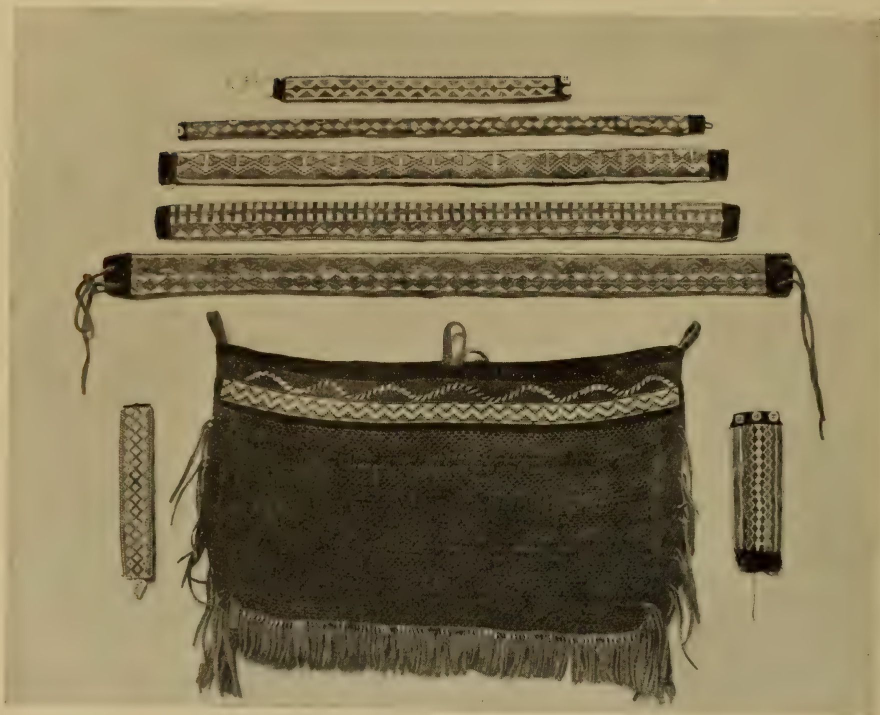


Fig. 10. Quill woven bands and a bag decorated with the same. See wall case, south side of Woodland Hall.

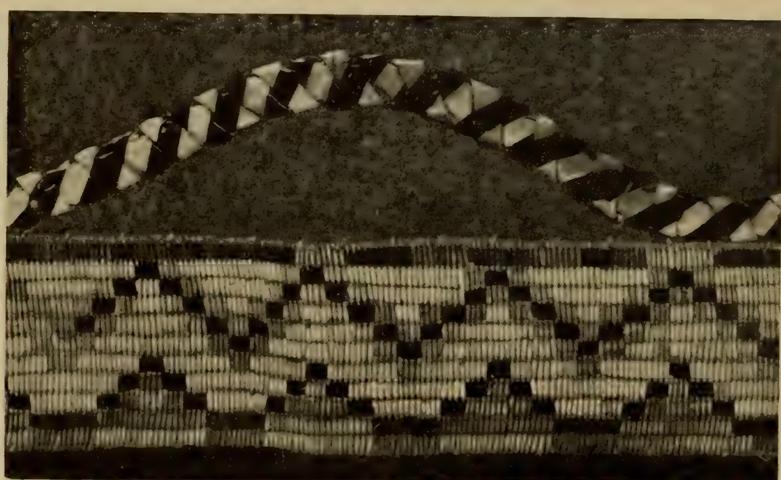
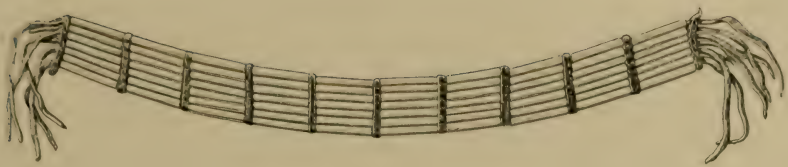


Fig. 11. Section of quill weaving from border of the bag in Fig. 10.



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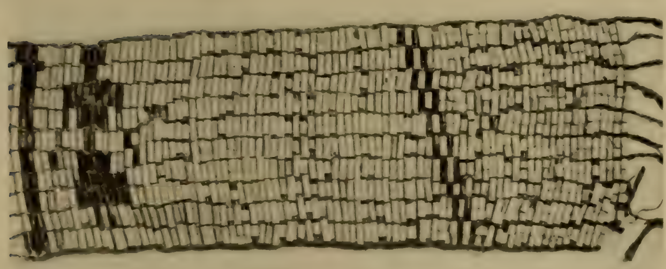

b

Fig. 12. Examples of Bead Weaving.

(a) A bead necklace. These long tube-like glass beads are said to replace similar sections of quills. Shoshoni case, Plains Indian Hall.

(b) Wampum belt. The famous wampum belts of the Iroquois are examples of bead weaving. The form of bead and the general appearance of the belt suggest quill weaving on the one hand and the bead necklace on the other. Woodland Hall.

DESIGNS.

The designs among the Plains Indians are justly celebrated for their geometric character. To be fully appreciated they must be seen in color instead of in mere outline as in this booklet. They were intended for costume decoration and used out-of-doors in the open and the sunlight. Under such conditions the colors tended to blend into their surroundings and to lose much of their harshness. The true place such decorations held in Plains Indian life is suggested by the accompanying photograph of two Blackfoot women.

A general similarity is found among the beaded designs for all the Plains tribes, but the choice of colors for backgrounds differs. Some of the finest work comes from the Dakota (Sioux) who use white as the background; however, some forty years ago they used a light blue.

The Indians around the Great Lakes seldom use geometric patterns, but incline to floral motives. Naturally, in their woven work they somewhat conventionalize these floral patterns, but in all cases the plant forms are obvious. On the other hand in their embroidery, where there are no limitations, they attain highly realistic effects. (See the Menomini and Ojibway cases.)

The contrast between these two types of beadwork will appear if you closely examine the collections in the Eastern Woodland Hall and then those in the Plains Indian Hall.

NAMES FOR DESIGNS.

The Indian bead workers often have names for their designs to facilitate discussion among themselves. Many of these names have highly figurative meanings that suggest true symbolism. The best series of such design names as used in beadwork was collected for this Museum from the Arapaho Indians, a list of which is given on the following pages. All of these designs are from specimens in the Museum and the names were supplied by the maker of each piece. A typical series of these are on exhibition in the Arapaho cases, Plains Indian Hall. Additional examples of design interpretation are shown in the Dakota cases. Naturally, tribes differ in the use of these names and not infrequently groups of workers in the same tribe have different names for the same design.

BLACKFOOT WOMEN IN FULL DRESS.

This photograph shows the place beadwork holds in the life of the Plains Indians. However, to fully appreciate its decorative value one must see it in the original colors and settings.

Fig. 13. Beaded Pouches—Dakota.

It should not be inferred that when we find names for beaded designs, the makers produce them solely for mystic reasons. That would be far from the truth, for beadwork is, above all, decorative. The Indian woman toils because it is a pleasure to produce something beautiful and chooses her colors and designs to that end. Yet she may choose a design which because of its name and symbolic associations, appeals to her as especially appropriate to the occasion. For example, the Arapaho moccasin in Fig. 14 is beaded around the edges, but has its front surface traversed by a number of quilled lines. The white beadwork represents the ground. Green zigzag lines upon it are snakes. The quilled lines represent sweathouse poles. These lines are red, blue, and yellow, and the colors represent stones of different colors, used for producing steam in the sweathouse. At the heel of the moccasin, which is not shown in the figure, are two small green squares. These represent the blankets with which the sweathouse is covered.

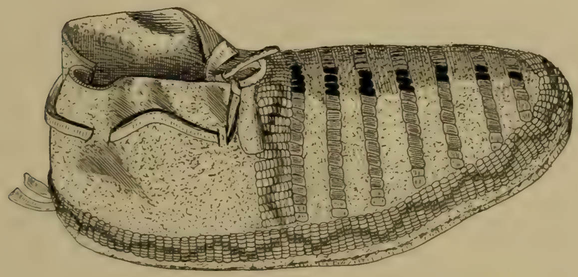

Fig. 14. A Child's Moccasin: Arapaho. The decoration has a symbolic meaning.

The design of a snake was embroidered on this moccasin in order that the child wearing it might not be bitten by snakes. The symbols referring to the sweathouse were embroidered on the moccasin in order that the child might grow to the age at which the sweathouse is principally used; namely, old age.

Thus we see how colors and established designs may be chosen for ornamental reasons and yet adapted to a wish or idea in the mind of the worker. But not all examples of beadwork have this significance for the same artistic excellence may be sought and attained with no thought of design names and the ideas they may call up.

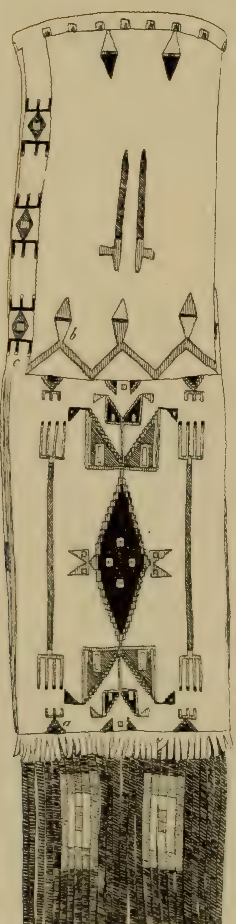

Fig. 15. Design from a Dakota Pipe Bag.

The bag is in the case for Dakota art, Plains Indian Hall. This is a good example of how a pictorial meaning may be read into a design. Thus the maker of this bag made the following statement: The whole represents a battle scene. The white is snow. The two long green lines are to indicate the flight of arrows. The projecting lines at the end represent the wounds made by the arrows. The arrow point is represented by the triangular figures opposite the projecting lines, these being shown again as attached to the point of the arrow (*a*). The large central figure is the body of a man: the diamond-shaped portion representing the trunk, and the appendages, the head, arms, and legs. The dark blue color of the trunk-figure implies that the man is dead. The small white rectangles enclosing a red spot represent the hits or wounds that brought the man down. On the upper part of the bag the border figure (*c*) represents a victory in which the owner's horse, represented by the green diamond-shaped figure, was wounded, as shown by the red area within the horse symbol; *b* represents a feather, and implies that the owner of the bag was entitled to wear an eagle feather in his hair as a sign that he had killed an enemy. The figures of the pipe indicate the owner's right to carry the official peace pipe.

The parts of this design are not new and so not original with the maker of the bag, but were selected by her to express these ideas and events, relating to the life of the man for whom she made it. Even the choice of designs was not wholly original, for it was the custom of her people to look upon certain designs as having a fixed meaning. Thus by looking at his pipe bag another Indian might read the deeds of the owner.

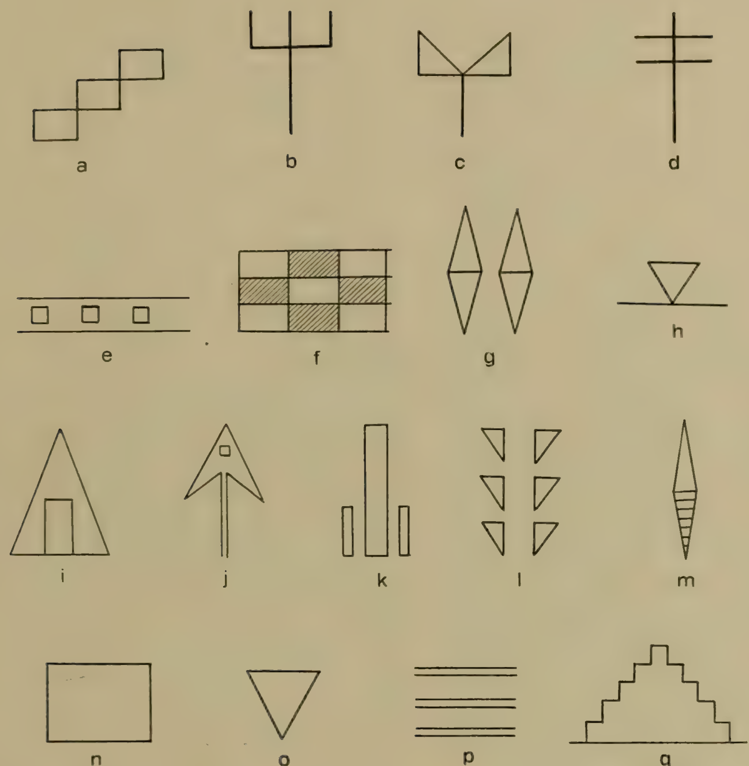

Fig. 16. Design Elements used by Dakota women in constructing beadwork. Each design unit has a name, used in giving instruction to beginners. The names in use twenty-five years ago are as follows:–

a, Twisted
b, Full-of-points
c, Forked tree
d, Dragon-fly
e, Filled up
f, Tripe
g, Feathers
h, Leaf
i, Tent
j, Arrow
k, Three-row
l, Vertebræ
m, Whirlwind
n, Bag
o, Pointed
p Trails
q, Cut-out

a *b*

Fig. 17. Ojibway or Chippewa Beadwork.

These two types of bandolier are fine examples of bead weaving (a) and embroidery (b). For other examples see Ojibway and Winnebago cases, Eastern Woodland Hall.

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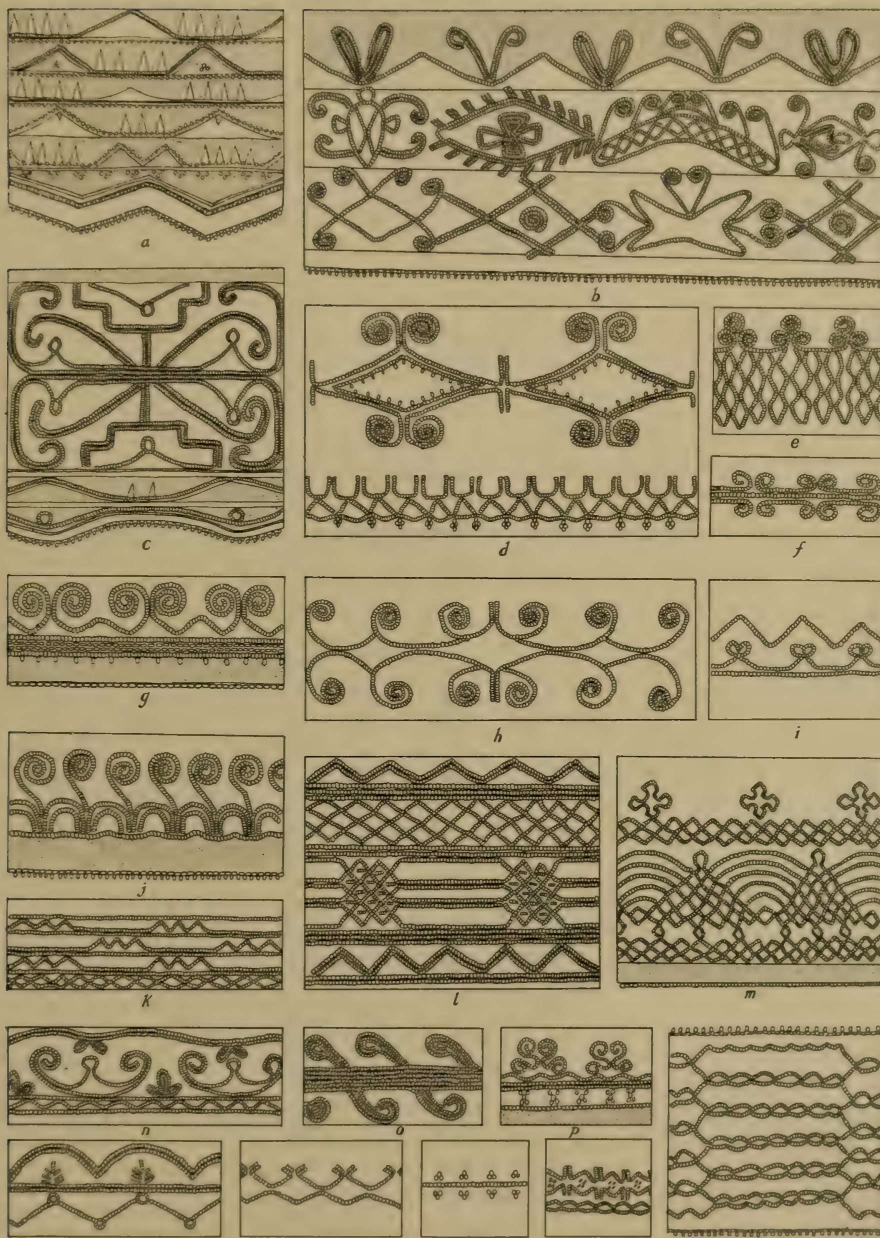


Fig. 18. Beadwork Designs from the Ojibway, Iroquois, and other Woodland Indians.

ELEMENTS OF BEADED DESIGNS FROM EXAMPLES IN THE MUSEUM.

The design elements in the following plates were selected from bead and quillwork collected among the Arapaho Indians by Professor A. L. Kroeber in 1900. Most of the objects from which they were taken are on exhibition. As a whole they represent the design material available to an Arapaho bead worker. They are also fairly representative of the Plains Indians as a whole. By custom these designs had come to have definite names and meanings, a list of which is added.

Figure	
1	Person
2	Person
3	Person
4	Person sitting
5	Person standing
6	Persons in tent or sweathcuse
7	Mythic dwarf
8	Navel
9	Navel string
10	Heart and lungs
11	Head
12	Eye
13	Eye
14	Eye
15	Track
16	Buffalo
17	Wolves
18	Rats
19	Eagle
20	Eagle
21	Eagle
22	Eagle
23	Thunderbird
24	Magpie
25	Swallow
26	Snake
27	Snake
28	Lizard
29	Lizard
30	Lizard
31	Turtle
32	Turtle
33	Turtle
34	Turtle
35	Frog
36	Fish
37	Bee
38	Bees
39	Butterfly

Figure	
40	Butterfly
41	Butterfly
42	Butterfly
43	Butterfly
44	Beetle
45	Dragon-fly
46	Dragon-fly
47	Dragon-fly
48	Cricket
49	Spider
50	Crayfish
51	Centipede
52	Centipede
53	Centipede
54	Leech
55	Caterpillar
56	Caterpillar
57	Caterpillar
58	Caterpillar
59	Caterpillar
60	Worms or maggots
61	Worm
62	Worm
63	Worm
64	Worms
65	Game, variety of animals
66	Bear foot
67	Bear foot
68	Bear foot
69	Buffalo intestine
70	Buffalo hoof
71	Buffalo hoof
72	Buffalo track
73	Buffalo path
74	Buffalo path
75	Buffalo wallow
76	Buffalo horns
77	Mythic cave of the buffalo

Elements of Beaded Designs

ELEMENTS OF BEADED DESIGNS FROM EXAMPLES IN THE MUSEUM—ARAPAHO.

Figure	
78	Cattle track
79	Cattle track
80	Horse cars
81	Horse track
82	Elk leg
83	Elk hoof
84	Deer hoof
85	Rabbit tracks
86	Beaver rib
87	Scales on beaver tail
88	Beaver dam and huts
89	Turtle claw
90	Turtle egg
91	Snake skin markings
92	Horned toad skin markings
93	Joints and stomach of frog
94	Markings of lizard
95	Bee hole
96	Ant hill
97	Ant hills
98	Ant hill
99	Ant path
100	Dragon-fly wing
101	Spider web
102	Centipede tracks
103	Worm hole
104	Tree
105	Trees on mountain
106	Trees on mountain
107	Trees on mountain
108	Leaf of "yellow herb"
109	Willow leaf
110	Mushrooms
111	Cactus
112	Mountain
113	Mountain
114	Mountain
115	Mountain
116	Mountain

Figure	
117	Mountain
118	Mountain
119	Mountains
120	Mountains
121	Mountains
122	Mountain
123	Snow-covered mountain
124	Snow-covered mountain
125	Valley or canyon
126	The earth
127	The earth
128	The earth
129	Dirt, clay
130	Rocks
131	Rocks
132	Rocks
133	Rocks
134	Rocks
135	Rocks
136	Rocks
137	Rocks
138	Rocks
139	Rocks
140	Path
141	Path
142	Path
143	Crossing paths
144	Holes in a path
145	Holes in a path
146	Path going over a hill
147	River
148	River
149	River
150	River with islands
151	River
152	Spring
153	Lake
154	Lake

Elements of Beaded Designs

ELEMENTS OF BEADED DESIGNS FROM EXAMPLES IN THE MUSEUM—ARAPAHO.

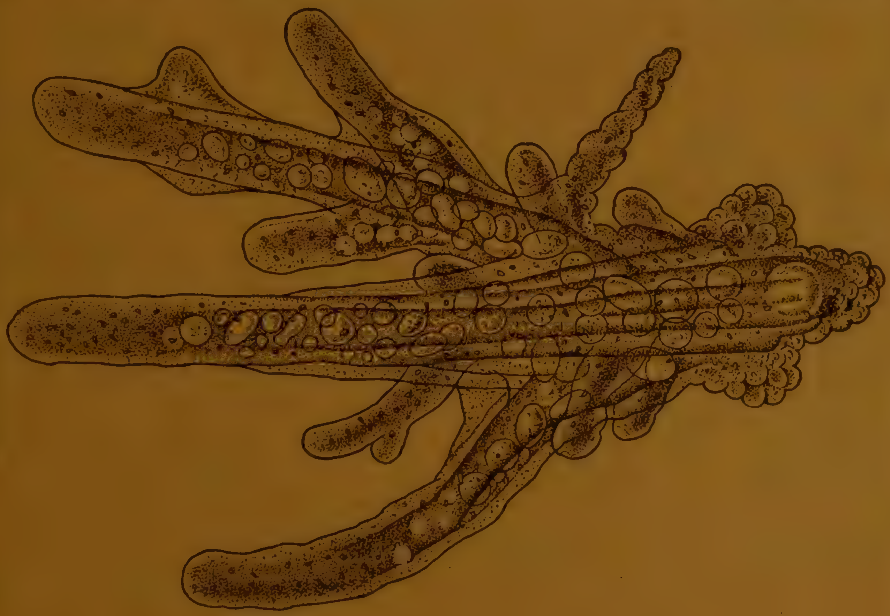
Elements of Beaded Designs

ELEMENTS OF BEADED DESIGNS FROM EXAMPLES IN THE MUSEUM—ARAPAHO.

Elements of Beaded Designs

AMERICAN MUSEUM OF NATURAL HISTORY

A FIRST CHAPTER IN NATURAL HISTORY



By FREDERIC A. LUCAS

GUIDE LEAFLET No. 51

EDITION OF 1920

A FIRST CHAPTER IN NATURAL HISTORY

BEING THE INTRODUCTION TO CHAMPLIN'S YOUNG FOLKS' CYCLOPÆDIA OF NATURAL HISTORY

By

FREDERIC A. LUCAS

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GUIDE LEAFLET No. 51

April, 1920

Where you may find illustrations or examples of some of the subjects noted in this leaflet

THE DARWIN HALL OF INVERTEBRATES

The exhibits in this hall, on the first floor, give a complete synopsis of the Animal Kingdom, all groups from Protozoa to Vertebrates being represented. Here too are groups illustrating relation to environment, the **Struggle for Existence, Survival of the Fittest, Geographical Distribution and Variation in Nature** and **under Domestication.**

THE SYNOPTIC SERIES OF MAMMALS

The attention of teachers of biology in our schools is called to the Synoptic Series of Mammals in The American Museum of Natural History, on the third floor, which has been developed with a special view of making it instructive to the student while at the same time of interest to the general visitor.

It not only comprises examples of every family of existing mammals, illustrating in many cases their structure, and origin in point of time, but includes exhibits showing various points in the evolution of mammals, sundry principles of classification, and interesting or peculiar habits. The specimens are, or are to be, accompanied by detailed descriptive labels giving the characters and more important information in regard to the various orders and families of mammals, the series being an example of Doctor Goode's definition of a (university) museum, "a collection of labels illustrated by specimens."

Among the subjects illustrated are albinos and melanos, modifications of the limbs for locomotion, structure and modifications of teeth, variations in the character of the brain, influence of environment and adaptation of mammals to their surroundings. What may be called an introductory chapter gives the distinctive characters of mammals, and a family tree, showing the probable lines of evolution of the animal kingdom and the relation of *Mammals* to the other great groups or *phyla*, is in course of preparation.

THE HALL OF INSECT LIFE

In the next hall is the collection of Insects so arranged as to illustrate their relationships to each other and to other animals (**Classification**), their importance, and such topics as **Protective Coloration, Mimicry**, and **Evolution.**

A First Chapter in Natural History

NATURAL HISTORY is the story of all natural objects, plants and minerals, as well as animals, though in popular usage it is often confined to the last. And while the term animal is very commonly thought to refer to mammals only, it being a mistake of frequent occurrence to speak of birds and animals when birds and mammals is meant, the name animal properly applies to every living or animate creature, from the tiny being that can be seen only with the aid of a microscope up to a whale, the mightiest creature that has ever lived.

Broadly speaking, animals are distinguished from plants by their ability to feel, move, and digest organic substances such as plants and other animals. Plants on the other hand to not feel, have no power of voluntary movement, and are nourished by inorganic substances absorbed through their roots. The boundary line between animals and plants is, however, not sharply defined, especially between the lower, or simpler, forms. Some plants move and some animals are rooted to one place, and a few plants even have the power to digest animal substances, but with all these exceptions the power of voluntary movement remains the most evident distinction between animals and plants.

EVOLUTION

The smallest and simplest animals consist of an extremely minute quantity of a jelly-like substance, termed protoplasm, surrounding a central speck of firmer material known as the nucleus. This constitutes a cell, and the smallest, simplest animals are formed of a single cell and are called unicellular or single-celled animals. The largest of creatures is merely a vast assemblage of very similar cells, grouped into structures of different kinds and serving different purposes; and a few naturalists have argued that even the very highest animals are really compound beings made up of combinations of simple animals. We may, however, dismiss this theory as fanciful, while noting that plants, as well as animals, are composed of combinations of cells, the cell being the unit of life.

All life is believed to have begun with simple, one-celled beings, because the animals we find entombed in the rocks become simpler and simpler in structure as we go down, the higher groups of mammals, birds, reptiles, etc., disappearing one after the other as we go backwards

in time. For the reason that the simpler forms of life appeared first, it is thought that plants preceded animals, and as the lowest forms of each are almost indistinguishable from one another, both may have been derived from the same simple organism. While this belief is entirely probable, it may never be actually proved: because the small, soft, simple animals and plants could leave no trace of their former presence in the shape of fossils; and the only animals found are those high enough in the scale of life to possess hard parts that could be preserved as fossils.

As living things increased in the world, they were influenced by their surroundings, and affected by the amount of light and heat, of rest or movement, to which they were subjected. In places favorable to their growth and increase, they multiplied to such an extent that they began to crowd one another, and localities suitable for the support of a limited number were even overpopulated, and it became a question as to which should survive. Thus, almost at the outset arose the **Struggle for Existence**, but it must be borne in mind that this was not an active struggle, but usually a mere passive effort to endure—such animals as by their strength, powers of endurance, and ability to withstand changes of climate and to resist heat or cold, being those that survived, while the weaker or less fit were swept out of existence. This is the very simplest form of the **Survival of the Fittest**; among higher animals the process is vastly more complicated, and the means by which it is accomplished so varied as to be almost infinite. It is nevertheless purely passive on the part of the animals, not being brought about by any thought or conscious effort on their part. Animals think to a certain extent, but the reader is cautioned to beware of ascribing to other animals the thoughts and feelings of man; this is the more important, as so many books have been written in which animals are made to feel, and think, and act like human beings, the height of absurdity being reached when these thoughts and feelings are ascribed to plants. The care of birds for their young is often cited as a beautiful example of parental tenderness; but while birds, it is true, care a great deal for their young, it is not much in the manner in which human parents care for their children. The bird that will do all in her power one season to preserve her offspring, will transfer her affections the very next year to a new brood, and treat last year's family as strangers, or even enemies.

Bats furnish a good example of what may be called passive resistance. These active little animals are for the most part insectivorous—insect eaters, and dependent entirely on the presence of insects for their

livelihood. Insects in turn are directly or indirectly dependent on flowers, and when in northern regions the approach of winter puts an end to the flowers, insects begin to disappear. With the withdrawal of their food supply, bats must either migrate, die, or in some manner survive without food. To a limited extent bats do migrate; but the majority exist without eating by hibernating during the winter—the same cold which puts an end to flowers and insects checking the circulation of blood, and permitting the bats to exist for a long time with very little bodily waste. This very curious condition has not been brought about by any direct effort on the part of the bats, but, it is believed, simply by the weeding out of those that were unable to lie torpid, and the survival of those in which the bodily functions and waste of flesh were checked without destroying life.

It must always be borne in mind that the survival of the fittest is by no means the survival of the strongest: for while size and strength count for much in the struggle between animals of the same kind, they count for little in combating nature, a fact which we see over and over again in studying the history of the past. Those great reptiles, the Dinosaurs, mightiest of all land animals, were swept out of existence while the smaller and weaker mammals survived. And, after these had attained to supremacy, the lumbering Titanotheres succumbed in their turn, and other types, smaller and weaker but better adapted to the changes that were taking place, succeeded them. Small animals, as a rule, have certain advantages over their larger relatives in the struggle for existence; they breed more rapidly, reach maturity sooner, are more readily concealed, and require less food: so that they are able to subsist through periods of drouth and cold which cut off the supply of food of the large animals and cause them to perish of starvation. As a result of the weeding out process, the influence of their surroundings, and what seems an inborn tendency to vary,[1] animals changed more or less in form and habits, becoming adapted to the changing conditions under which they lived, resulting in the **Evolution** of new kinds of animals. In this manner very wonderful modifications have been brought about: for we see some animals dwelling in the heat of the tropics, and others equally at home amid the snow and ice of arctic regions; some passing their lives high on the mountain tops, some dwelling a mile or more in the depths of the ocean where the temperature is but little above freezing, and some quite at home in springs whose waters almost reach the boiling point.

[1]There are two very different views in regard to this point, one that change in the surroundings *causes* the changes in the animals, the other that it simply allows the tendency to vary to assert itself. Both are probably true, as is the case with both sides in many quarrels—perhaps in most.

Among the many changes that have been brought about in the process of evolution, is the matter of **Protective Coloration**—the resemblance of animals to their surroundings, or, in some instances, to one another, by which they are enabled to escape their enemies. Birds, like snipe, meadow larks, and quail, and mammals, such as the common gray rabbit, so harmonize with the dried grass, leaves, and brush amid which they live that it is a difficult matter to see them when at rest. Desert-haunting animals, many mice, or on a large scale, some of the African antelopes, also blend with their surroundings, and so do the spotted young of many shore birds that are brought up on pebbly beaches. On the other hand parrots and fruit pigeons are largely green, and thus elude observation among the trees in which they live. Then there are some very interesting cases of animals that are doubly protected, changing their raiment with the season, harmonizing with leaves and grass in summer and with the snows of winter. Such are the weasels, hares, and ptarmigans, and it is a curious fact that those which have an extensive north and south range, reaching regions where there is little or no snowfall, do not turn white in their southern homes. The white color of northern animals may not be entirely for their protection, but for their warmth as well, since white does not give out heat so rapidly as dark colors.

A most remarkable mode of protection exists in some marine animals which are almost as transparent as glass, the very blood being transformed to a colorless fluid, so that they can scarcely be distinguished from the water in which they dwell.

Still another method of protective coloration is shown by many edible species of animals that bear a strong resemblance in form and color to those that are presumably disagreeable on account of peculiarities in taste or odor. The term presumably disagreeable is used: for it by no means follows that because a given flavor is offensive to us, it is equally unpleasant to birds and other animals. We know from the few careful experiments which have been made, that insects repugnant to us are eaten by various animals. Also it is very evident that although the vast majority of animals are good to eat they nevertheless are not eaten out of existence.

In some cases colors that at first sight seem conspicuous are really protective, as are the stripes of the tiger and the spots of the leopard and jaguar, which so suggest patches of light and shade that the animals crouch unseen in the jungle. In these particular instances color is not necessary for protection, but is of service while the animals are stalking their prey.

For protective coloration is by no means a one-sided matter or else many animals would go hungry, but while it helps some to elude their enemies it is also of service to predatory beasts in stealing upon their quarry. The dun color of many African antelopes is undoubtedly a protection, but the dun color of the lion blends with that of the desert sand and enables him to steal unseen upon the protected antelope. There is, to add a word of warning, much reason to think that entirely too much importance has been ascribed to protective coloration and that it is by no means so effective as its more ardent advocates would have us believe, since it is to a great extent offset by keenness of sight, acuteness of smell and sharpness of hearing on the part of both the hunter and the hunted.

Given a tendency among animals to vary, it is easy to see how protective coloration might have been brought about by Natural Selection. Any animals that chanced to resemble their surroundings in color so as not to be readily seen on the sand, or among the leaves or grass as the case might be, would have a little better chance of being overlooked by hungry enemies than those that were conspicuous, the result being the killing off of the conspicuous animals and the gradual establishment of a race of animals protectively colored.

In regard to these various questions of natural selection, survival of the fittest, and evolution of animals, it may be said that while we do not, and never can, actually *know* that these things have taken place as described, careful study of the facts renders it probable that such has been the case. One of the oft remarked characteristics of mankind is a desire to knew the causes of things, and if man can not ascertain all the facts he will frame some theory to explain those that are available.

If animals are affected by their surroundings, we would expect to find that those which dwell where the conditions vary least, have changed the least; we would also expect that the simplest animals, those that have the fewest parts to change, bear the strongest resemblances to those that lived in the earlier days of the world. And this is exactly what is shown by the study of the past, the differences between living and extinct animals bearing a direct relation to these two things. Among the highly organized mammals, not a living species is directly related to those of that early period of the earth's history we call Eocene, while very few go back beyond the (geologically) recent period known as Pliocene. By the aid of fossils we are able to trace some, notably the horse, back through the various changes they have undergone; but when this is done the early species are found to be so different from their living descendants

that without the aid of the intermediate forms the relationship between the two would not be suspected. The direct relatives of many reptiles are found much further back than are those of mammals, while some living fishes belong to the same family and even the same genus as those that existed so long ago as the Cretaceous Period. As for invertebrates, and especially some shellfish, a few go back unchanged for periods of time representing millions of years; down in the depths of the sea, in uniform quiet, cold and darkness, they have lived an unvarying existence for æons of time, while what we term the eternal hills have been washed away, and others upheaved to take their places.

Thus evolution, or change among animals, has gone on more and more rapidly as higher forms came into existence.

Knowing the great changes that have taken place among animals since they first appeared in the world, we are able to account for existing differences we find between them. Some groups have steadily progressed, a few have degenerated; some have diminished in numbers and many have disappeared.

If we open a fan, and imagine that the sticks represent various divisions of animals, we shall have a rough illustration of what might have taken place had their development been uniform; all have a common point of origin, but the farther we go from this point, the more widely are they separated, although the relationship of one to another may easily be seen. If now we break some of the sticks at different places and whittle down some of the ends, we shall have gaps of varying widths at various places, and the ends will be of unequal size and at irregular distances from one another, as are the groups of living animals.

For example, while there are but two living species of elephants, one in Asia, and another in Africa, fossil remains indicate that there were formerly a large number of species inhabiting all the continents save Australia. And, as the history of the elephants is followed backwards, we find, even with the small amount of material now at our disposal, that their characters gradually change, and that they may be traced to much smaller animals not unlike tapirs. In this instance, not only are the sticks of the fan broken, but the one representing the elephants is whittled down to two species. The horse is probably the best example we have of an unbroken line of descent, and most educated people are aware that its pedigree may be traced to a race of animals no larger than a collie dog which also gave rise to other and very different groups of animals. The stick representing the horse family is entire, but not so large as it was.

Owing to the various facts just mentioned it is impossible to arrange animals in a straight line from lowest to highest; each animal is not only related to those before and behind, but to those on either side of it, and if one group of animals is compared with another it will be found that the lower members of one will be decidedly lower or simpler in structure than the highest members of the preceding group. The relations of animals to each other are often expressed in the form of a tree. The trunk represents the common origin of animals, the branches the great groups (see Classification), and the tips of the twigs individuals. Only it must be remembered that in the tree of life as we now see it many of the branches are lacking.

The questions of evolution and of the animals that formerly existed are directly connected with the problem of distribution.

GEOGRAPHICAL DISTRIBUTION

Animals are not spread indiscriminately over the earth, but certain kinds or species are found in particular regions, some being confined to comparatively small areas, while others are widely distributed. Llamas are found only in South America; one kind of elephant occurs in Africa, another in parts of Asia; the moose, represented by three closely related species, circles the entire northern hemisphere, while the orang-utan is restricted to a small part of Borneo, a second species being limited to a still smaller portion of Sumatra. This distribution is termed **Geographical Distribution**, and the branch of geography devoted to it—zoological, or more briefly zoögeography, the corresponding study of plant distribution being phytogeography. The problems of zoögeography are very complicated; for many causes have brought about the dispersal of animals, or caused their restriction to certain regions.

The means by which animals that walk, swim, or fly have been distributed are apparent, while those less able to get about in the world are subject to winds, rivers, currents, floods, and accidental transportation by other animals. The distribution of some takes place while they are still in the egg, or very small: for many animals, like the oyster, which are rooted to one spot when old, are free to wander while young. This may bring about results that at first sight seem contradictory, creatures whose powers of locomotion are small having a wider range than some well able to travel about. Such cases may sometimes be explained by the fact that the more active animals are less subject than the others to accidental dispersion, and are not swept away from places where food is abundant and enemies few. There are, however, many instances

where the reasons for the restriction of animals to certain places are by no means evident. Great bodies of water are most effectual barriers to the spread of many animals, some are hemmed in by mountain ranges, others by deserts, but back of such obvious causes lies the all-important question of food, and this, so far as land animals are concerned, depends on temperature, which determines the distribution of plants and of the animals directly or indirectly dependent on them for subsistence.

New Zealand and Australia are the most striking examples of the effect of wide stretches of water on the distribution of animals: for, save two species of bats, not a single mammal is found in New Zealand, while the mammalian fauna[1] of Australia consists almost entirely of marsupials, the only other land animals being the dingo, or wild dog, supposed to have been introduced by man, and a few little rodents. In the first case it is inferred that if New Zealand has ever been connected with any other land, it was before the appearance of mammals on earth; in the latter instance, the deduction is that Australia has been isolated since the Cretaceous Period, when the lower types of mammals had appeared, and that its peculiar assemblage of animals is the result of evolution within its own boundaries.

A very important point that must be taken into account in dealing with the distribution of existing animals is the distribution of extinct animals: for this often accounts for the presence of related species in widely separated parts of the world. Tapirs are examples of this discontinuous distribution, one species being found in Malaysia, while the others dwell in the warmer parts of America. These places are widely separated, and by no possibility could these animals now pass from one locality to the other; but remains of fossil tapirs or tapir-like animals are found in various parts of the world: so we know that existing tapirs are the survivors of a once numerous race of animals.

Such cases as this are taken as evidence of the former union, direct or indirect, of countries now widely separated, some animals being much more important witnesses than others. Birds, which pass over long distances with ease, are of comparatively small importance as evidence, although they have some value, while fresh-water shells, and, above all, fresh-water fishes, furnish testimony of the most value. The lung-fishes, Dipnoi, one of which is found in Australia, one in South America, and one in Africa, are usually brought forward as a case in point. It is extremely improbable that such peculiar fishes could have originated in-

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[1]The fauna of a country is the sum total of its animal life, the flora, of its plant life, while the term biota embraces both, meaning the entire plant and animal life of any region or period.

dependently in three widely separated parts of the world, and as they inhabit fresh water they could not have crossed the sea; it is also known that they belong to an old group of former wide distribution, their fossil remains being found in Europe and North America. So it is considered that at some very distant period of the world's history there was a land connection between Australia, Africa, and South America, and that during this period the distribution of the Dipnoi took place, a conclusion that derives support from other evidence.

Thus the life of the past has not only been continually changing, but has its bearing on that of the present time. As the world changed, new forms arose fitted to new conditions, race after race of animals came into existence, flourished for a time and then passed away, existing animals being those best adapted to live under present conditions.

The story of the past life of the earth is usually considered by itself and that branch of science is termed Palæontology.[1] This is mainly a matter of convenience, because the subject is so great in itself, for the life of the past has its direct bearing on that of the present and to understand one it is necessary to have a knowledge of the other.

NOMENCLATURE

Some things about the study of natural history, or rather about the published results of this study, often seem peculiar and unnecessary, prominent among them being scientific names and the classification of animals, two matters that are intimately related. When men began really to study animals, and to publish the results of their observations, the descriptions were printed in Latin, this being the language used by students and familiar to men of liberal education in all countries. In order that the animals might be readily recognized, it was customary to preface the account of each with a brief description of its more evident characteristics, something much like what is now called a diagnosis. The lion, for example, might be styled the tawny colored cat with a mane; the tiger, the striped cat; the leopard, the large, many spotted cat, and so on. And to this day many naturalists preface their descriptions with a brief Latin diagnosis. As the tide of commerce of the eighteenth century brought to Europe scores of animals before unknown, the number of recognized species increased so rapidly that it became difficult to keep track of them. To overcome this difficulty, the great Swedish naturalist, Linnæus, devised the plan of giving to each animal two names, the

[1]From the Greek *palaios*, ancient *on*, a being, and *logia*, to speak; in other words, a treatise on ancient beings or life.

first a general, or generic, name, which should indicate the group to which the animal belonged, the second a special or specific name, to apply to that animal alone, this method of naming animals and plants being known as the binomial (two-name) system of nomenclature. So the lion became *Felis leo*, the lion cat (the adjective comes last in Latin); the tiger *Felis tigris*, the tiger cat; and the leopard *Felis pardalis*, the spotted cat, the common name *felis* indicating that they were of the same genus or kind.

While zoological names thus began in descriptions, they have ended by becoming merely convenient handles by which to lay hold of any particular animal; so at present names do not *necessarily* have any meaning, or contain any reference to the characteristics of the animal to which they are applied, although customarily they do so. It is very much the same with our own names. Time was, long ago to be sure, when the names of people were descriptive, just as they are even now among Indians and savage races. But Black, White, Strong, Smith, and Carpenter have ceased to mean anything save that their bearer is a member of some particular family who has his own special name also. But, it is frequently asked, why can't animals have common as well as scientific names? One reason why many animals have no common names is that they are not commonly known, but a better reason is that there are not enough names to go around. While our largest dictionaries claim to define only some 300,000 words, more than 350,000 species of animals, great and small, have already been described, and at the present rate of discovery the number will probably reach 500,000 within twenty years. Therefore, as they are not commonly known, it is obviously impossible to have a common name for each one, and so they are recorded only by scientific names.

It must also be remembered that a large proportion of these scientific names seem strange and formidable only because they are unfamiliar; and those that have worked their way into our acquaintance, such as elephant, rhinoceros and boa constrictor, do not seem at all strange.

Some may also complain that scientific names are being constantly changed, but this is true only to a limited extent, and is due partly to a few individuals who decline to be guided by any rules, and partly to the working of what is called the law of priority—the rule that the specific name first applied to any animal is the one that shall be used. As some of these names first appear in rare or little known books, it often happens that a name long current is found to be antedated by another, and must, therefore, be changed.

It will be found that some of the animals described in books have not only two, but three names, and this means that they belong to a particular race, or subspecies, of some well recognized species. It was once thought that species were unchangeable, and that animals were sharply distinguished from one another, but as they were more carefully studied, and more specimens were available, it became evident that individuals from a given part of the range or habitat of a species, might be slightly different from the standard—those dwelling in desert regions being a little paler than the majority, and those residing in damp, wooded localities being somewhat darker. To such local groups or geographical races, the name of *subspecies* (under-kind) is applied, and the study of this is a part of the study of geographical distribution.

CLASSIFICATION

Classification is merely the orderly arrangement of animals, or other objects, placing those most closely related to one another in a class by themselves and arranging the groups thus formed with reference to their degree of relationship. In the case of animals, this results in the formation of groups of varying size and importance, the principal being Species, Genus, Family, Order, Class, and Phylum, while for purposes of greater exactness intermediate assemblages may be made, such as superorder, subclass, subfamily, and so on, the prefix *super,* above, meaning greater than, and *sub*, under, less than.

The entire Animal Kingdom is divided into large branches or phyla, a Phylum[1] being a large assemblage of animals that have had a common line of descent and agree in some very important character. Thus the classes Mammals, Birds, Reptiles, Batrachia, and Fishes form parts of the Branch or Phylum Vertebrata, or backboned animals, which are distinguished by having a more or less complete internal skeleton of cartilage or bone.

The first division of animals was into vertebrates and invertebrates, according as they did or did not have a backbone, but it was soon recognized that the invertebrates differed among themselves quite as much as they did from the vertebrates. So Cuvier divided them into Radiates, Mollusks, and Articulates, and as our knowledge of animals has increased so also has the number of groups into which they are divided: for a system of classification is merely an expression of the present state of our knowledge of animals.

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[1]From the Greek *phylon*, a tribe.

Phyla are divided into Classes[1] whose many (often thousands) members are constructed on the same general plan. The mammals, for example, have hot blood, a four-chambered heart, and suckle their young; all birds have feathers; reptiles have cold blood and are never clad in either hair or feathers. But while these are very apparent differences they are associated with others, equally important if not so obvious, which can be expressed only in technical language.

Classes in turn are divided into Orders[2] which embrace one or several Families. Thus the cats so closely resemble one another in structure that all living and many extinct species are included in the family *Felidæ*, whose most evident character is the great development of the canine teeth, the reduction in number of the jaw teeth and the adaptation of a few of them for cutting flesh; whence these teeth are called sectorial teeth.

Another familiar order is that containing the gnawing animals, or rodents, known as Glires. This contains more species and individuals than any other order of mammals, a large proportion being included in the well known family *Muridæ* that embraces the rats and mice.

Related families are the *Hystricidæ* or porcupines, *Dipodidæ*, jerboas, and *Sciuridæ* or squirrels.

The order Bruta contains those stupid, brutish creatures the sloths, anteaters and armadillos. It has also been termed Edentata, or toothless, some of the members lacking teeth altogether, while all agree in being destitute of front or incisor teeth. To the Ungulata, or hoofed quadrupeds, in whose ranks are found the deer, *Cervidæ*, belong also the sheep, goats and cattle of the family *Bovidæ* and the horses or *Equidæ*.

The dogs form the family *Canidæ*, the bears the *Ursidæ*, these, with several others, being embraced in the order *Feræ*, known also as *Carnivora* or flesh eaters—the beasts of prey—which contains those animals not merely adapted for a predatory life, but agreeing in some important characters of teeth and skeleton. The mere fact that any animal is a flesh eater does not make it a member of the order *Feræ*, any more than living in the water makes a creature a fish, for habits are not characters, although they may be characteristic. Some of the Marsupials, or pouched mammals, are flesh eaters and prey upon other animals, but they are very different from the true carnivores. While whales live in the water they breathe air by means of lungs, and not by gills, their blood is warm, their young are born alive and are nourished on milk, their back

[1]Latin *classis*, a class.
[2]Latin *ordo*, a row or series, hence an order is a series of animals.

and tail fins have no fin rays, and the bones of the side fins are like those of the fore leg of a quadruped. In all these points they differ from fishes and agree with other mammals.

The Genus[1] is next below the family and includes animals that have some character or characters in common, though differing from one another in smaller, or specific characters. Like the groups already dealt with a genus may contain one, or many species; for one species may differ so much from any other as to require a place, or genus, by itself, while a number of distinct species may possess some common character. Thus a large proportion of all squirrels belong in the genus *Sciurus*, and the true cats, great and small, the lion and the common cat (for size has nothing to do with relationship) are included in the genus *Felis;* the short-tailed cats are placed in the genus *Lynx*, and the hunting leopard or cheetah, whose claws are only partly retractile, and cannot be drawn within their sheaths as in other cats, in the genus *Cynælurus*.

Lastly comes the Species,[2] whose members constantly resemble one another in all essential particulars of form, size and color, the exceptions being the geographical races or subspecies mentioned elsewhere. The species may be called the unit of classification, and subspecies may be looked upon as fractions.

Still using the lion as an illustration, the various groups to which this animal belongs are: Phylum, *Vertebrata;* Class, *Mammalia;* Order, *Feræ*, Suborder, *Fissipedia* (split-footed or clawed); Family, *Felidæ;* Genus, *Felis;* Species, *Leo*. This is clearly shown in the accompanying table illustrating the position of the Lion in the Animal Kingdom.

Anyone who examines a few systems of classification may find that they do not agree with one another in all points: this, however, is no more surprising than that people differ in matters of religion, politics, or schools of medicine. Any system is to some extent an expression of individual opinion, and two persons will rarely agree on all questions, even in natural history.

It may appear strange that one order should contain only one or two species, while another comprises hundreds, even thousands. But the importance of a group does not depend on the number of species it includes, but on the extent to which these resemble or differ from those of other groups, orders, or families, as the case may be; fifty cents make a larger pile than does a single dollar, but they do not form a more im-

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[1]Latin *genus*, a race or kind.
[2]Latin *species*, a particular sort: be sure never to say *specie*.

DIVISIONS OF THE ANIMAL KINGDOM

ILLUSTRATING THE POSITION OF THE LION

(*Extinct Groups are not included*)

ANIMALS
370,000 species

PHYLA or BRANCHES

- *Vertebrata* — Back-boned Animals
- *Arthropoda* — Jointed Animals, as Crabs, Insects, etc.
- *Mollusca* — Shell-fish
- *Molluscoidea* — Brachiopods, etc.
- *Vermes* — Worms
- *Echinodermata* — Sea-urchins, Starfish
- *Cœlenterata* — Sea-anemones, Corals
- *Porifera* — Sponges
- *Protozoa* — Single-celled Animals

CLASSES

- *Mammalia* — Mammals
- *Aves* — Birds
- *Reptilia* — Reptiles
- *Amphibia* — Frogs, etc.
- *Pisces* — Fishes
- *Marsipobranchii* — Lampreys

ORDERS

- *Primates* — Man and Monkeys
- *Feræ* — Beasts of Prey
- *Chiroptera* — Bats
- *Insectivora* — Moles and Shrews
- *Glires* or *Rodentia* — Gnawers
- *Proboscidea* — Elephants
- *Hyracoidea* — Hyraxes
- *Ungulata* — Hoofed Animals
- *Cete* or *Cetacea* — Whales
- *Sirenia* — Manatees
- *Bruta* or *Edentata* — Sloths, etc.
- *Effodientia* — Pangolins, etc.
- *Marsupialia* — Pouched Mammals
- *Monotremata* — Echidnas, etc.

FAMILIES

Fissipedia
- *Felidæ* — Cats
- *Viverridæ* — Civets
- *Hyænidæ* — Hyænas
- *Protelidæ* — Aard Wolves
- *Canidæ* — Dogs
- *Ursidæ* — Bears
- *Procyonidæ* — Raccoons
- *Mustelidæ* — Weasels

Pinnipedia
- *Otariidæ* — Eared Seals
- *Phocidæ* — Earless Seals
- *Odobænidæ* — Walruses

GENERA

- *Felis* — True Cats
- *Cynælurus* — Cheetah
- *Lynx* — Lynxes

SPECIES

- *Felis leo* — Lion
- *Felis tigris* — Tiger
- *Felis leopardus* — Leopard
- *Felis onca* — Jaguar
- *Felis concolor* — Cougar or Puma
- *Felis uncia* — Ounce
- *Felis pardalis* — Ocelot
- *Felis catenata* — Linked Ocelot
- *Felis macroura* — Long-tailed Ocelot
- *Felis tigrina* — Margay
- *Felis serval* — Serval
- *Felis domesticus* — Domestic Cat
- *Felis caffra* — Egyptian Cat
- *Felis chaus* — Jungle-cat
- *Felis ornata* — Indian Desert-cat
- *Felis manul* — Pallas's Cat
- *Felis pajeros* — Pampas-cat
- *Felis catus* — Wild Cat

portant assemblage. So the order Proboscidea contains only two living species of elephants, but zoologically it is even more important than the Glires, or rodents, which includes the majority of all mammals.

This classifying of animals may be compared to the organization of an army composed of thousands of individuals (species) distinguished as officers and privates (genera) formed into companies (families), regiments (orders) and brigades (classes) which in turn constitute divisions (phyla), the whole vast total forming an army like the animal kingdom.

So the classification of animals is merely an expression of their degrees of relationship to one another and enables the naturalist to place his species as a general does his soldiers.

LIFE AND TIME

The existing plant and animal life of the world is the result of evolution through long geologic ages, during which race after race of animals came into being, flourished for a time, and wholly or largely died out. The table on a following page shows the estimated age of the world, the length of different periods in the past during which this evolution took place, the predominant life of these periods, and the point of origin, so far as known from fossils, when this life began.

As we are dependent on fossils for our knowledge of the life of the past it may be well to devote a few lines to the subject of

HOW FOSSILS ARE FORMED

based on Dr. Matthew's account in the **General Guide.** A fuller description may be found in **Animals of the Past.**

In a general way, fossils are the petrified remains of plants or animals that lived at some past period of the earth's history, but they include such things as trails left by worms and other creeping things and footprints of animals on the sands of time. In many instances we have not the objects themselves but only their casts or impressions in the rocks. This is particularly the case with shells. Sometimes, as with the bones of the great Irish elk, the objects have been buried in swamps or bogs, and in a few rare instances, as with the mammoth and woolly rhinoceros, entire animals have been preserved for thousands of years in ice or frozen mud. Fossils are found in localities where the dead animals or plants have gradually been buried under layers of sediment to such a depth that they come in contact with the mineral waters of the earth and finally become petrified, the essential point

being that they are covered by water, or at least buried in wet ground. Later through subsequent upheaval and erosion they are again brought to or near the surface of the earth. Petrifaction is the slow replacement of animal or vegetable material by such minerals as carbonate of lime or silica. The process is very slow and for this reason flesh is never petrified. Fossil beds are found in every continent. In our own country, Texas, Montana, Wyoming, and the Bad Lands of South Dakota are famous for their large fossil beds, and many of the finest and rarest fossils in the Museum were obtained in these localities.

As it takes thousands of years for the various layers of earth to accumulate over the bones, and for the latter to become petrified, the study of fossils and the strata in which they are found is an important aid in determining the age of the earth and the succession of life thereon.

The **Divisions of Geologic Time** are based on the character of their life as indicated by fossils.

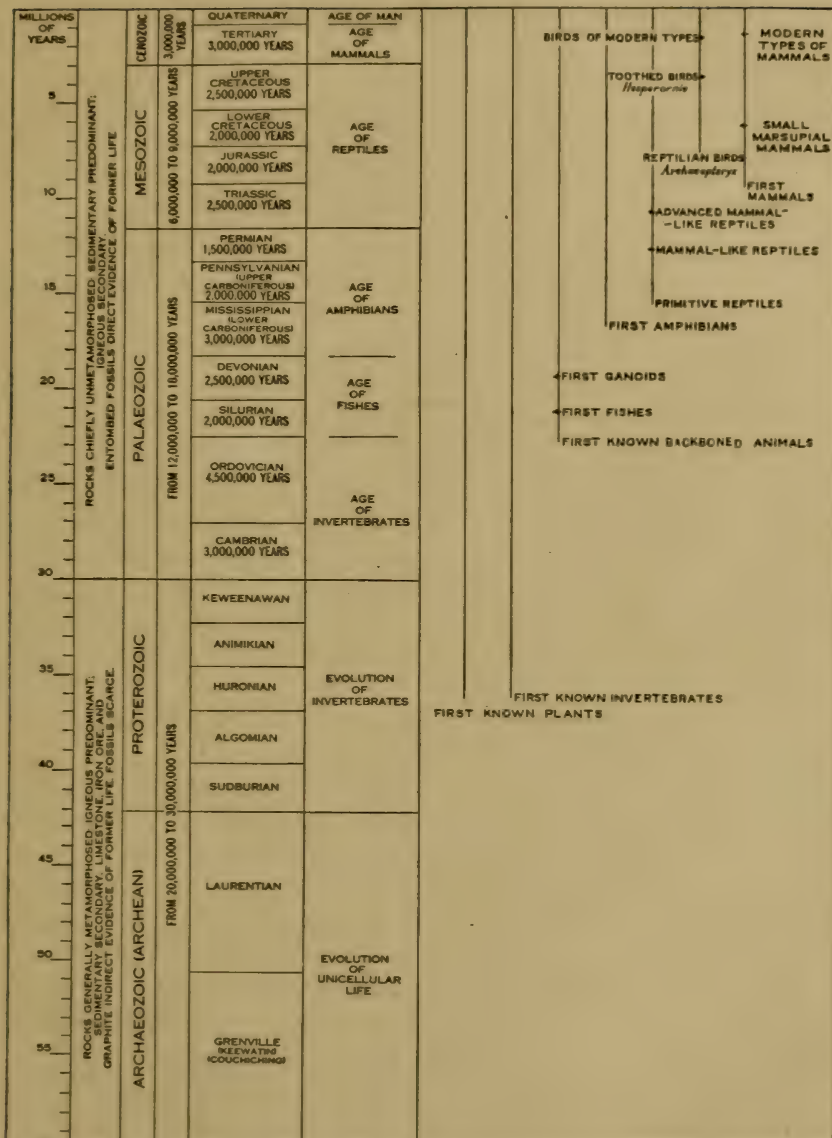
The estimated **Duration of Geologic Time** is based largely on the thickness of the rocks.

Exhibits relating to the geologic history of the earth, and its past life, will be found on the fourth floor of the Museum. Those in the Hall of Geology illustrate the structure of the earth, include examples of the various rocks of which it is composed, and are accompanied by fossils showing the general character of the life of the different geologic periods and the steps or stages that have led to the animal life of the present.

Proceeding to the Southeast Pavilion and going westward, one passes from the hall devoted to fossil fishes, through those containing reptiles and mammals, coming finally to the Hall of the Age of Man, and in a few minutes witnesses changes that required millions of years for their accomplishment. The strange armor-clad fishes, unlike any now living, were succeeded by amphibians and reptiles, among them curious creatures like Naosaurus and the great dinosaurs which in their day were the rulers of the earth. Here are huge herbivorous reptiles like Brontosaurus and Triceratops and the flesh-eating creatures that preyed upon them, including Tyrannosaurus. the most formidable beast of prey that ever lived. They passed out of existence and gave place to the mammals, and these underwent many changes before the forms of to-day appeared. Lastly came man, a weakling compared with the animals by which he was surrounded, which include such forms as the mammoth, mastodon and great ground sloths, and yet, by reason of his superior brain and its servant the hand, coming to dominate them all.

Many of the animals shown in these halls are described in Handbook **Animals of the Past**, another is devoted to **Dinosaurs,** and leaflets discuss **Mammoths and Mastodons** and the **Evolution of the Horse.**

LIFE AND TIME



Prepared by Dr. Chester A. Reeds.

Based upon time estimates of Walcott and Schuchert.

SOME MUSEUM PUBLICATIONS

OF USE IN CONNECTION WITH THIS LEAFLET

ANIMALS OF THE PAST. By FREDERIC A. LUCAS

A popular account of some of the creatures of the Ancient World; tells of Mammoth and Mastodon, the great Sea Reptiles, the Dinosaurs and giant Birds. 250 pages with 41 illustrations by Charles R. Knight and Joseph Gleeson. Paper, 50 cents.

No. 5. DINOSAURS. By W. D. MATTHEW, Ph.D., Curator of Vertebrate Palæontology. December, 1915, 102 pages, 49 illustrations. Paper, 30 cents.

An account of these huge monsters, describing also the conditions under which they lived and flourished and telling of their distribution in the days when the earth was young and how their bones are discovered, collected and mounted.

No. 36. THE EVOLUTION OF THE HORSE IN NATURE AND UNDER DOMESTICATION. By W. D. MATTHEW, Ph.D., Curator, Department of Vertebrate Palæontology, and S. H. CHUBB. September, 1913, 64 pages, 39 illustrations. Price, 25 cents.

The past geologic history of the Horse affords the most complete and convincing illustration of evolution among mammals. This leaflet, based upon material in this Museum, describes the successive stages in its evolution from the four-toed "*Eohippus* no bigger than a fox" to the single-toed horse of to-day.

No. 43. MAMMOTHS AND MASTODONS. By W. D. MATTHEW, Curator, Department of Vertebrate Palæontology. November, 1915, 25 pages, 12 illustrations. Price, 15 cents.

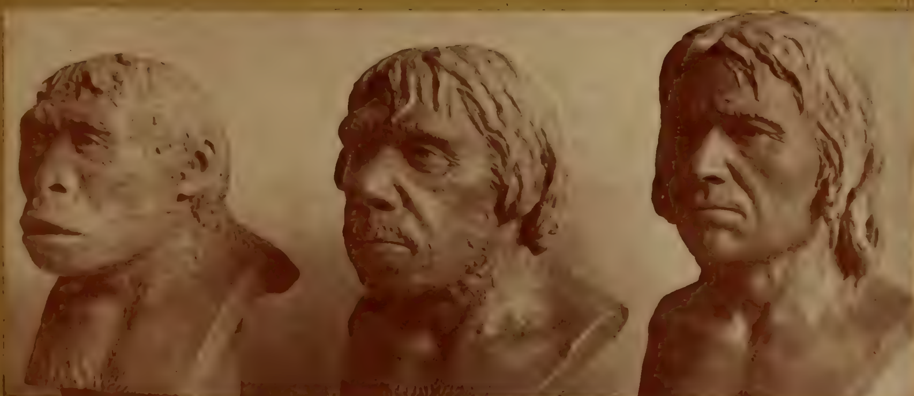
These extinct relatives or ancestors of the existing elephants have been found in every part of the habitable world except Australia. They and their remains are described and figured in this leaflet.

No. 42. THE BIG TREE AND ITS STORY. By GEORGE H. SHERWOOD, Curator, Department of Public Education. New edition, April, 1915, 23 pages, 9 illustrations. Price, 10 cents.

This big tree started in life in 500 A.D., and during the fourteen hundred years of its existence occurred all the more important events of history, while what we term biology, or the knowledge of living things, has been acquired during the last three hundred years of its growth.

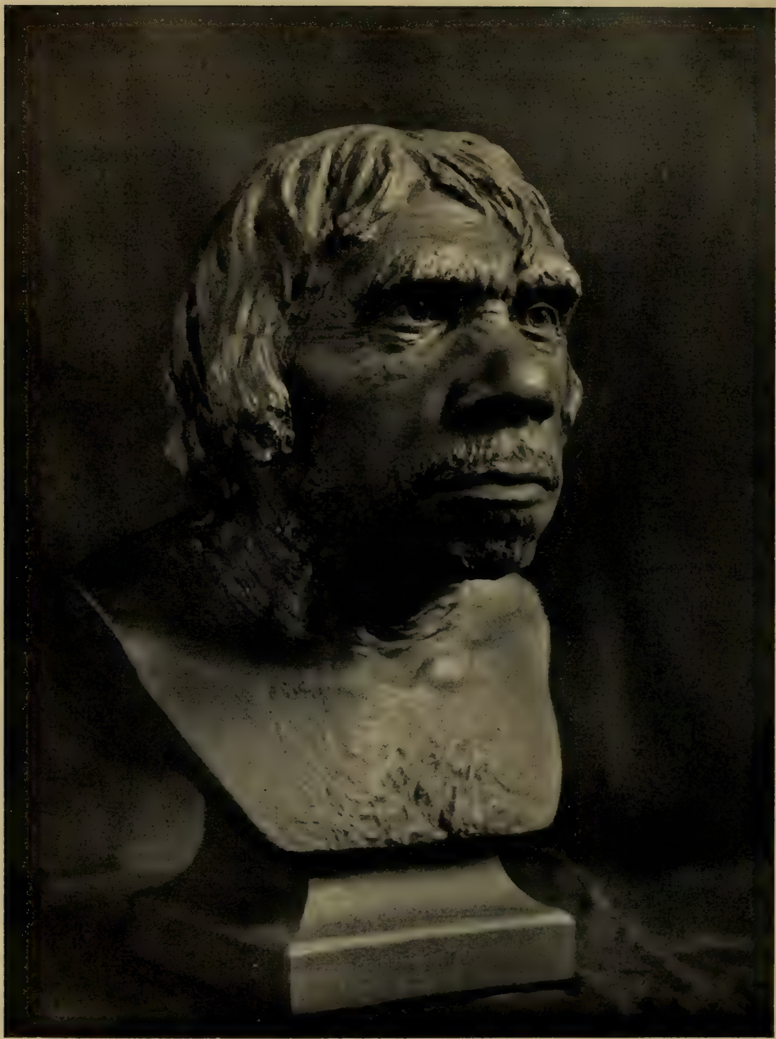
AMERICAN MUSEUM OF NATURAL HISTORY

THE HALL OF THE AGE OF MAN



By HENRY FAIRFIELD OSBORN

GUIDE LEAFLET SERIES, No. 52 MAY, 1921



NEANDERTHAL MAN

Modeled by Dr. J H. McGregor on cast of skull found at la Chapelle aux Saints, France in 1908.

From restorations by J. H. McGregor

TRINIL APE-MAN *Pithecanthropur erectus* | NEANDERTHAL MAN *Homo neanderthalensis* | CRÔ-MAGNON MAN *Homo sapiens*

That these three restorations of prehistoric man form a progressive series, from left to right, is evident not only by the general form and the appearance of relative intelligence appreciated by the most casual observer, but especially by definite anatomical characters such as increased prominence of the chin, reduction of the eyebrow ridges, reduction of the prominence of the lower face as a whole, increased size of skull and of brain capacity (brain capacities of the three races from left to right: 858–900cc.; 1408cc.; 1550–1880cc.)

The Hall of the Age of Man in the American Museum

By HENRY FAIRFIELD OSBORN

Reprinted, with slight changes, from *Natural History*, the Journal of the American Museum of Natural History, for May-June, 1920, pages 228-246.

The exhibits in the Hall of the Age of Man are intended to illustrate what is known of the origin, relationships and early history of man, as deduced from his remains and primitive implements, and also to show the animals by which he was surrounded in the early stages of his existence. These animals are shown not only as mounted skeletons but in a series of large mural paintings portraying them as they appeared in the flesh amid their natural surroundings. These paintings are the result of the study of their fossil remains and their careful comparison with related existing animals, a work to which the author has devoted many years of study. Hence they give an accurate and vivid idea of the animals that were the contemporaries of man in various regions in the infancy of the world.

Five cases in the center of the hall are devoted to the story of man, and that it can be compressed into so small a space is an indication of the scarcity of his remains, for here are displayed reproductions of all the notable specimens that have been discovered. It has been necessary to use copies, for the actual specimens are few in number and scattered through many museums in many widely separated parts of the world.

THE beginning of the Age of Man, some 500,000 years ago, roughly estimated as the close of the Age of Mammals, marks in reality but the beginning of the close of the Age of Mammals. The extinction of the most superb mammals that the earth has ever produced, during the early stages of human evolution, progressed from natural causes due directly or indirectly to the Glacial epoch. With the introduction of firearms the destruction has proceeded with increasing rapidity, and today it is going on, by the use of guns and steel traps, at a more rapid rate than ever. By the

middle of this century man will be alone amid the ruins of the mammalian world he has destroyed, the period of the Age of Mammals will have entirely closed, and the Age of Man will have reached a numerical climax, from which some statisticians believe it will probably recede, because we are approaching the point of the overpopulation of the earth in three of the five great continents.

The Ascent of Man

The cradle of the human race was, in our opinion, in Asia, in regions not yet explored by palæontologists. One reason that human and prehuman fossil remains are rare is that the ancestors of man lived partly among the trees and forests; this does not mean that they were arboreal; they lived chiefly on the ground. Even when living in a more open country the ancestors of man were alert to escape the floods and sandstorms which entombed animals like the horse of the open country and of the plains. Hence fossil remains of man as well as of his ancestors are extremely rare until the period of burial began. Only two races, the Heidelberg and the Piltdown, are certainly known from the river drifts and gravels before the period of burials.

The human remains known consist principally of portions of skulls, of jaws, and teeth of members of these races. Individuals are now represented by casts in the hall of the Age of Man. The museum series began in 1915 with the gift of the J. Leon Williams Collection, and has been enriched by additions from the museums of London, Paris, and recently of the Neanderthal man of Krapina, presented by Professor K. Gorjanovič-Kramberger, also the Talgai skull from South Australia, presented by Dr. Stewart A. Smith.

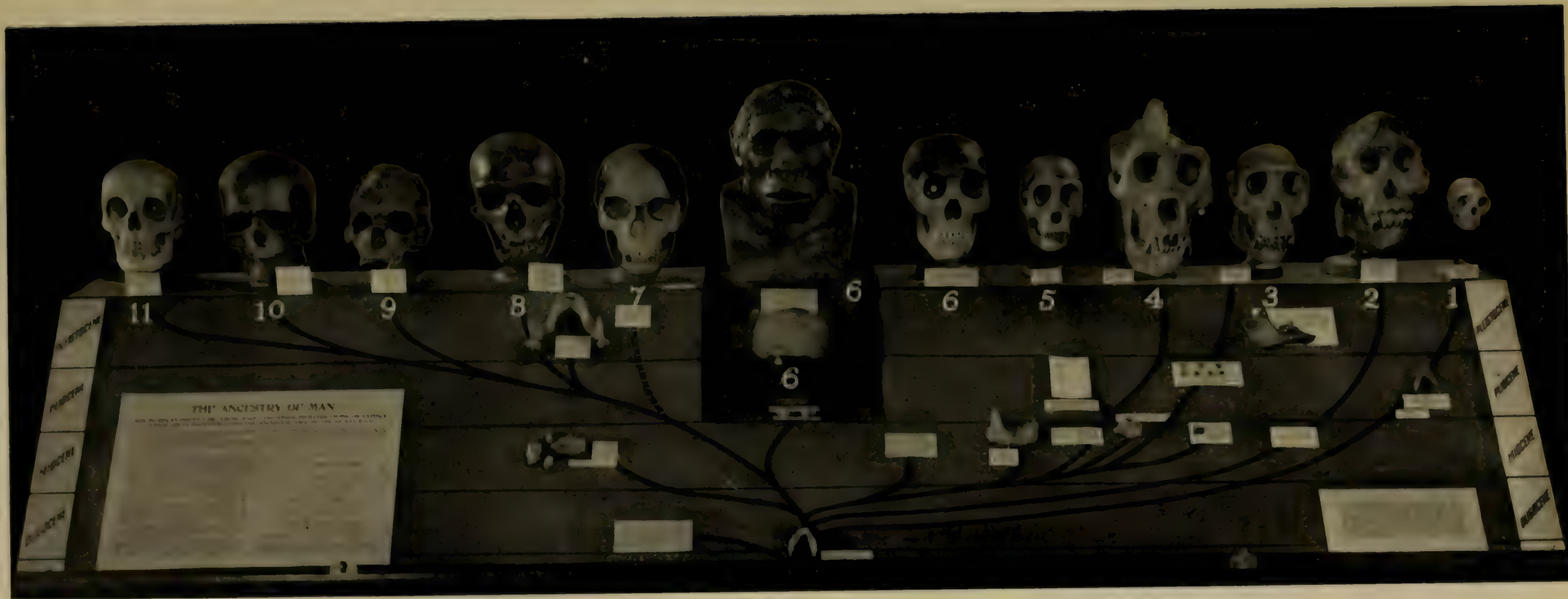
Man as a Primate

The ascent of man as one of the Primates was parallel with that of the families of apes. Man has a long line of ancestry of his own, perhaps two million or more years in length. He is not descended from any known form of ape either living or fossil. One hypothetical ancestral stage, of which we have a small jaw (see middle bottom of exhibit in Case I, opposite page) found in the Oligocene of northern Egypt, is the *Propliopithecus*, which in the opinion of Professor W. K. Gregory, of the American Museum, our leading authority on the anthropoids, is at least structurally ancestral to the higher apes and man—in other words a possible prehuman link. From such an animal possibly four branches were given off leading respectively to the living orangs, the gibbons, the chimpanzees, the gorillas, and some of their fossil ancestors.

All these great man apes are distinguished from man by being more or less arboreal in habit; they are shown to be very far removed from the large-brained walking line which gave rise to our ancestors. Our own immediate ancestors did not live in trees; they were erect or semi-erect for a very long period, perhaps as far back as Miocene time. Back of this, perhaps a million years ago, was a prehuman, arboreal stage.

The Trinil ape-man, the *Pithecanthropus* of Java (see center of Case I) is the first of the conundrums in human ancestry. Is the Trinil race prehuman or not? The restored head by Professor J. Howard McGregor, of Columbia University, is designed to show its half human, half anthropoid resemblance, as suggested by the top of the cranium, the only part known. which is far more human than that of any ape cranium, and at the same time far more apelike than that of any human cranium. It is not impossible that this ape-man is related to the Neanderthal man (skull shown in Case 3.

In this exhibit of the great man apes



MAN'S PLACE AMONG THE PRIMATES

Case I in the hall of the Age of Man, the American Museum, showing the "Trinil race" of Java and other primates, living or extinct, which aid in reconstructing the ancestral tree of the human race

In the right half of this case are arranged the skulls of certain anthropoid apes—gibbon (1), orang (2), chimpanzee (3), adult gorilla (4), young gorilla (5), while on the left are models of skulls of the known races of man—Piltdown (7), Neanderthal (8), Talgai (9), Crô-Magnon (10), recent (11). Between these two groups have been placed a restoration of the skull and of the head of the "Trinil" or ape-man of Java (*Pithecanthropus erectus*) and a cast of the actually discovered brain case and two of the teeth (6, 6, 6).

The ascent of man has in general paralleled that of the families of anthropoid apes, as is shown by the "tree of descent" in black lines. Man is not descended from any known ape, either living or fossil, but a hypothetical ancestor of this entire anthropoid group, founded on a jaw discovered in Egypt (see case at bottom center), is the *Propliopthecus haeckeli*. The case is ruled horizontally to indicate five periods (the most ancient, at the bottom, does not show in the photograph) of geological time (Eocene, Oligocene, Miocene, Pliocene, and Pleistocene), and below the recent apes are placed casts of the jaws or teeth of certain fossil apes, which have been discovered in deposits of these different geological periods.

On the human side of the case, immediately below No. 8, the Neanderthal skull, is shown a cast of the massive Heidelberg jaw (shown also in Case II, No. 7, representing a race which was perhaps the predecessor of Neanderthal man in Europe. Below this and on another branch are casts of teeth and fragments of jaw of a primitive fossil ape of India (*Sivapithecus indicus*), the patterns of whose molar teeth somewhat resemble those of man, but still more those of the orang. The card on the base line just left of the middle bears the drawing of the jaw with teeth of a fossil primate, *Parapithecus*, from Egypt, the most primitive of all known Old World monkeys and apes and considered to be the Oligocene survivor of an ancient type ancestral to the ancient *Propliopithecus haeckeli*

(at the left in Case I) are placed for comparison some of the known extinct or fossil races of man, each ascending along a line of its own. Copies of the most recent discoveries in various parts of the world are placed in this series; in fact, this entire exhibit is designed to show from time to time our progress in discovery, to present actual evidence in place of theories and speculations, and to show how very limited this evidence is as compared with the abundant evidence in the ancestry, for example, of the horse (shown in the hall of the Age of Mammals).

The Most Ancient Human Races, Heidelberg and Piltdown

Unquestionably the most ancient human relic which has thus far been discovered is the jaw (see reproduction in Case II, left) of the so-called Heidelberg man, a fossil which may be 250,000 years old. From it has been modeled by McGregor the Heidelberg skull, which is very similar to the Neanderthal skull. The Heidelberg man may be ancestral to the Neanderthal man (shown in Case III).

A few deep brown fragments of a skull and jaw and one tooth (see casts in Case II, at the right) represent all the remains known of the Piltdown man, discovered in England a few years ago. Two reconstructions of the Piltdown skull have been made; the original by Professor A. Smith Woodward in London, in the British Museum, the second in this country by McGregor. The problem whether the Piltdown jaw belongs to this human skull or whether it belongs to a fossil chimpanzee is still not actually settled. The skull itself is of a rather fine type, with a flat forehead like that of the existing Bushmen of South Africa.

The Neanderthal Race, the Missing Link

The Neanderthal man represents the oldest fossil human race of which the skeleton is fully known. The remains are relatively abundant, and the American Museum owns reproductions of many skulls and parts of skulls found during the last half century in Spain, Germany, France, and Hungary. Foremost of these is the skullcap found near Düsseldorf, Germany, in 1856, which constitutes the type of the Neanderthal race itself.

Of great interest is the reconstruction by McGregor of a Neanderthal female head, based upon a skull found at Gibraltar in 1848, which gives us the head characters of the women of this very primitive race. All the remains discovered of the Neanderthal men are represented by reproductions in the American Museum excepting one, that of La Quina, France, which has just been presented by the United States National Museum.

Foremost in perfection is the skull from La Chapelle-aux-Saints, originally restored by Professor Marcellin Boule and reconstructed by McGregor. The latter distinguished American expert in the anatomy of palæolithic man is now engaged upon the reconstruction of the entire skeleton and body of the Neanderthal man. We may predict that this life-size Neanderthal model will be one of the most interesting exhibits in the American Museum when the work is finally completed after the many years of laborious study and research put upon it.

The Neanderthal Flint Workers (Mural I)

The mural of the Neanderthal group of flint workers shows in the distance, along the Dordogne River, herds of woolly rhinoceroses and woolly mammoths. The center of interest is the flint industry, which, with the chase, occupied the entire energy of the Neanderthals. This group awaits the completion of the Neanderthal body restoration by McGregor. Since the Neanderthal type is totally different

THE MOST ANCIENT HUMAN RACES

Case 11 in the hall of the Age of Man, the American Museum, showing the Heidelberg and the Piltdown man of the early part of the Old Stone age in Europe, from before 100,000 B.C. to about 45,000 B.C.

The most ancient fossil relic of man is the massive jaw (7, just left of center) which was found near Heidelberg in deposits of the second Interglacial stage, perhaps as early as 200,000 B.C. A skull (8) has been modeled to fit this jaw by Professor McGregor. Of this skull the upper dental arch, the region of the cheeks, and the jaw articulations can be restored with a high degree of probability. The size of the brain case is more doubtful, but it was probably at least of the type of the Neanderthal skull.

The jaw is of truly remarkable size and strength and entirely apelike in form, especially in the absence of a chin, but the teeth are altogether human and small as compared with the size of the jaw.

Of very great antiquity, perhaps of 500,000 B.C., are the fragments of a skull (2) discovered at Piltdown, England, in conjunction with a number of flints and fossils—and a jaw which is still a matter of controversy. The skull and head of this Piltdown man have been restored by Professor McGregor (3, 4, 5). Number 4 shows a preliminary stage in the restoration of the soft parts of the head with clay cylinders attached to indicate the thickness of the flesh. Number 1, near the center of the case, shows casts of two eoliths, the most primitive form of rude stone implement and a primitive Palæolithic flint implement found in strata immediately above and around the fragments of the Piltdown skull; at 1, near the end of the case, are other flint implements found at Piltdown. Numbers 6, 6, 6 mark a collection of very primitive stone implements rudely edged or pointed. A feature of the Piltdown skull which distinguishes it from those of the Neanderthal type is the absence of eyebrow ridges. Although this is the most primitive and apelike human skull that has been found, it is nevertheless well advanced along the line of characteristically human evolution and shows a brain capacity estimated as at least between 1200 and 1300 cc., equaling or exceeding that of the aboriginal Australians

THE IMMEDIATE PREDECESSOR OF MODERN MAN, THE NEANDERTHAL RACE

Case III in the hall of the Age of Man, the American Museum, showing man of the Neanderthal type, in the Middle Old Stone age in Europe, from about 50,000 to 25,000 B. C. (Mural I of the human series, in the hall of the Age of Man, "The Neanderthal Flint Workers," is incomplete and a photograph cannot be presented at this time. The completion awaits the restoration studies, by McGregor, of the Neanderthal body.)

A race of long-headed men was established over western Europe before the last (fourth) Glacial period. Many of their stations have been discovered and a considerable abundance of fossil material, including practically complete skeletons. These represent what is probably a distinct species of man (*Homo neanderthalensis*), presenting some features never before found elsewhere combined in any human race and some quite outside the limits of variation of recent man. Number 1 marks a cast of the skullcap which constitutes the type of this species. The original was discovered in the Neander Valley, near Düsseldorf, Germany, in 1856; at 2 (upper) is a cast of a Neanderthal-like skull discovered at Spy, Belgium; while below this (2, lower) are casts of fragments of jaws from Malarnaud, France. Fragments of very ancient jaws from Krapina, Croatia, are shown in No. 3. These last date from the last Interglacial stage and represent a culture (Acheulean) which preceded the culture (Mousterian) of the typical Neanderthals. The skull found at Le Moustier (France) (4) is thought to be that of a youth of about sixteen years. Number 5 is a cast of a Neanderthal skull from La Chapelle-aux-Saints (France) with the superficial injuries corrected and the nasal bones, alveolar region, and the teeth restored. The three casts numbered 7 are respectively, from left to right, the female Neanderthal skull found at Gibraltar in 1848, a restoration of the same, and a reconstruction of half of the soft parts of the head. The lower jaw was restored from studies of ten other Neanderthal jaws. Number 8 shows stone implements of the so-called *coups de poing* type. The ovaloid forms with sharp edges may have served for knives, while the disk-shaped stone was probably a scraper. To the right of these implements are casts of twelve teeth discovered in 1910 on the Isle of Jersey in the English Channel. The central bust (6) is a restoration modeled by Professor McGregor on a replica of the Neanderthal skull by its side (5)

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph

CRÔ-MAGNON ARTISTS OF SOUTHERN FRANCE (MURAL II)

The work of arrangement is in progress on Case IV in the hall of the Age of Man, but is too incomplete to allow presentation of a photograph. Case IV will show the Crô-Magnon race at the climax of the Old Stone age. The mural of the Crô-Magnon artists, however, in the middle of the north wall, is completed, as shown above

Contemporaneously with the disappearance of the last Glacial period in Europe, a highly evolved race in no respect inferior to modern man entered that continent from the east and drove out or exterminated the Neanderthal race, of which they were both the mental and physical superiors. Their cultural capacity is indicated not alone by their physiognomy and the cubic content of their brain (see bust at the right on page 229), but has also been demonstrated by the handiwork and especially the artistic productions which they have left in the caves of southern Europe. The Palæolithic murals and sculptures in relief found on the walls of limestone grottoes in France and Spain indicate greater artistic sense and ability than have been found among any other uncivilized people. The mural above, painted by Knight for the hall of the Age of Man, represents four Crô-Magnon artists at work on the famous procession of mammoths as found in the cave of Font-de-Gaume, Dordogne, France. The two half-kneeling figures are holding lamps made of hollowed-out stones. The artist standing half erect is engaged in incising the outlines of a mammoth on the limestone wall with a sharp flint; the other artist is laying on the colors, employing a shoulder bone for a pallet. The kneeling figure is preparing colors from red or yellow ochre. The clothed man to the left is a chieftain who carries a *baton de commandement* on his staff as an insignia of his rank

from any modern human type, it must be studied from models of its own. The group is very carefully arranged to show the physical characters of this man: the knees slightly bent in the peculiar standing posture, the broad heavy shoulders slightly stooped, and the massive neck and the head set well forward. In the background is the famous cavern of Le Moustier which gives its name to the Mousterian period of flint industry pursued by the Neanderthals.

The Crô-Magnon Race of High Type

The highly evolved Crô-Magnon race entered Europe from the east and drove out the Neanderthals. This was a race of warriors, of hunters, of painters and sculptors far superior to any of their predecessors. The original type of the Crô-Magnon head belonged to an aged individual. We are now endeavoring to secure from France replicas of the Crô-Magnon skeletons buried in the grottoes of Grimaldi near Mentone, which are by far the most perfect known. The contrast between the Crô-Magnon heads and those of the Neanderthals which precede them is as wide as it possibly could be. The Crô-Magnons were people like ourselves in point of evolution, and the characters of the head and cranium reflect their moral and spiritual potentiality.

Crô-Magnon Artists Painting the Mammoth (Mural II)

One of the great murals in the hall of the Age of Man (over the doorway opposite the Crô-Magnon exhibit) represents four of the Crô-Magnon artists actually painting the great fresco in the cave of Font-de-Gaume, Dordogne, France. The writer has been studying the composition of this group for years, with Mr. Charles R. Knight, artist, aided by advice of the Abbé Henri Breuil of the Institut de Paléontologie Humaine, Paris, as well as of Mr. N. C. Nelson, archæologist at the American Museum of Natural History.

There are six figures in the group; four are depicted partly nude to show their anatomy in contrast with that of the Neanderthals. The two half-kneeling figures are holding up small lamps to illuminate the smooth surface of the limestone wall on which the procession of mammoths is being depicted. The half-erect figure represents an artist with pointed flint incising the outlines of a mammoth on the wall. The fully erect central figure represents an artist laying on the colors. A kneeling figure is preparing the colors on a rock. The artists and their assistants have laid off part of their fur clothing in order to work more freely. This design enables the painter to show the tall, slender proportions of the men of this Crô-Magnon race. The standing figure to the left is that of a chieftain clothed in well-made fur garments, who carries on top of his staff his *baton de commandement* as the insignia of his rank. The only illumination is that of the flickering wicks in the small oil lamps.

Men of the New Stone Age

Men of the Neolithic, or New Stone age (see remains shown in Case V, the arrangement of which, however, is only in progress so that a photograph cannot be presented) used stone implements, partly chipped, partly polished. They hunted with the wolf dog. They brought in pottery. In central and southern France and in Switzerland they cultivated the ground and introduced cereals. Forerunners of these Neolithic men scattered over the Baltic shores and reached northern France.

The Neolithic Stag Hunters (Mural III)

This mural group also is in its place in the hall (at the west end), having been completed in 1919. It represents men of a northern race,

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph

"THE NEOLITHIC STAG HUNTERS," OF THE NEW STONE AGE (MURAL III)

Case V, in the hall of the Age of Man, illustrating the types and culture of the men of the New Stone age, is in process of arrangement

The progenitors of contemporary man in Europe, through a transition period between Palæolithic and Neolithic times (about 7000–1500 B.C.), introduced a new culture of polished stone and crude pottery, and either absorbed or displaced their upper Palæolithic predecessors. This mural, "The Neolithic Stag Hunters," now in place in the American Museum, at the middle of the west wall of the hall of the Age of Man, portrays the end of the hunt at an encampment on the border of one of the northern beech forests. The hunters with their stone-tipped spears are resting after the chase and have thrown aside parts of their fur garments. These Neolithic invaders were a powerfully built people with brown or fair hair and narrow heads—closely related to existing peoples of Scandinavia. The rigorous climate little encouraged the fine arts, but promoted endurance, tribal loyalty, and the rudiments of family life. Rude huts were constructed to take the place of caverns and shelters, but the most important cultural change was the introduction of a rudimentary agriculture with the use of a variety of plants and seeds. The men of the New Stone age also brought with them, or domesticated from the animals they found in western Europe, many of the same types of animals as are domesticated today, and they may possibly have been attracted to Europe by the abundance of horses of the forest and Celtic types. The chief's fair-haired son in the picture is shown leading a wolf dog, the ancestor of the sheep dog of northern France

brown- or fair-haired, hunters of the stag, living along the southern shores of the Baltic in the earliest stage of the New Stone age, a stage known as the Campignian from remains of huts and rudely polished stone implements found near Campigny in France. The scene is on the border of one of the northern beech forests and represents the return from the hunt. After the ardor of the chase the hunters have thrown off their fur garments. The chieftain in the center is partly clad in furs; in the coming winter season he will be wholly fur-clad. His son, a fair-haired youth with a necklace of bear claws, grasps a bow and arrow and holds in leash a wolf dog, ancestor of the modern sheep dog of northern France. The hunters, with spears tipped with stone heads, are resting from the chase. Two vessels of pottery indicate the introduction of the new ceramic art, accompanied by crude ornamentation.

This race was courageous, warlike, hardy, but of a lower intelligence and artistic order than the Crô-Magnons; it was chiefly concerned, in a rigorous northern climate, with the struggle for existence, in which the qualities of endurance, tribal loyalty, and the rudiments of family life were being cultivated. Rude huts take the place of caverns and shelters, which are now mostly abandoned.

These were tall men with high, narrow skulls, related to the existing Nordic race, more powerful in build than the people of the Swiss Lake Dwellings. Skulls and skeletons representative of this hardy northern type are abundantly known in Scandinavia, but have not found their way to our American Museum collections as yet.

The Great Mammals Hunted by Man

The hall of the Age of Man is planned to contain four chief collections of the mammals of the world during the period of the Age of Man.

In Europe man hunted the reindeer, the wild horses and cattle, and the mammoth. He used the hide of the reindeer for clothing, the flesh and marrow for food. He carved the ivory tusks of the mammoth. The mammoth, the northern, hairy type of elephant known to early explorers of fossil remains, was foremost among the great mammals hunted by man. The whole history of this proboscidean order is shown in the hall of the Age of Man.

The evolution of the proboscideans culminates in the mastodons and mammoths. This is one of the romances of evolution quite equal in interest to the evolution of the horse. This collection is by far the most complete in existence; it contains as much in the way of complete skeletons as those in all the other museums of the world combined. The early stages in the evolution of the proboscideans, beginning with the *Palæomastodon* discovered in the Fayûm region of northern Africa, carry us back into times far antecedent to the Age of Man, namely, into an early period of the Age of Mammals, the Oligocene. It has been deemed wise to collect here the entire history of the evolution of the proboscideans, which taken altogether is the most majestic line of evolution that has thus far been discovered.

Murals of the Four Seasons in the Glacial Epoch

The four great murals just completed on the north walls of the hall of the Age of Man represent scenes during the four seasons of the year near the close of the Glacial epoch in the Northern Hemisphere.

These four seasons belong in the same period of geologic time, namely, the final glacial stage, the period of the maximum advance of the glaciers over the entire Northern Hemisphere, of the most intense cold, and of the farthest southward extension of the northern types of mammals. This is

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph

THE WOOLLY RHINOCEROS IN A GLACIAL WINTER, NORTHERN FRANCE

This mural from the hall of the Age of Man, the American Museum (on the west wall, at the right), and the three following, represent the four seasons of the year in the Old Stone Age, near the close of the fourth Glacial period. This was the period of greatest glacial advance over the Northern Hemisphere and of the most southerly extension of the northern types of mammals; it was the time of the Crô-Magnons in Europe from whose paintings we derive knowledge of the mammoth, reindeer, and rhinoceros which then flourished

The most common of extinct rhinoceroses is the *Rhinoceros antiquitatis* or woolly Rhinocesos of Europe and Siberia. This species was most like the square-mouthed or white rhinoceros of Africa nearly extinct today. It was protected from the wintry blasts by a heavy coat of long hair and a thick undercoat of fine wool. This brown wool was found in a good state of preservation on the side of the face of one specimen discovered in the ice fields of Siberia, and is now in the Museum of Petrograd. In the distance can be seen a group of mammoths and a line of saigas—a species of antelope still found in Siberia. The rhinoceros kept closely to the ice sheet and never wandered so far south as did the mammoth. It was a plains dweller, living on grass and herbs

the time of the Crô-Magnon race, and our knowledge of the mammoths, reindeer, and rhinoceroses is derived from the actual Crô-Magnon paintings and etchings, chiefly those found within the caverns. The murals of the four seasons are as follows:

Midwinter.—The woolly rhinoceros in northern France.

Late Winter.—The reindeer and mammoth on the river Somme, France.

Midsummer.—The mastodon, royal bison, and horse on the Missouri River, in the latitude of Kansas.

Autumn.—The deer-moose, tapir, and giant beaver, in northern New Jersey.

The Glacial Winter in Northern France

The woolly rhinoceros, like the woolly mammoth, was heavily enwrapped in hair, beneath which was a thick coat of fine wool. With this protection the animal was quite indifferent to the wintry blasts which swept over the steppe-like country of northern France. This golden brown wool is actually preserved on the side of the face of one specimen discovered, which is now in the Museum of Petrograd. The head of the rhinoceros was long and narrow, like that of the white rhinoceros of Africa, but the jaws were narrower and the upper lips were more pointed. It is an animal quite distinct from the great black rhinoceros still extant in Africa, which is a grazer with broad lips. In the distance in the painting are shown the saigas, antelopes which wandered over France at that time, and a group of woolly mammoths.

Scene on the Somme River in Northern France

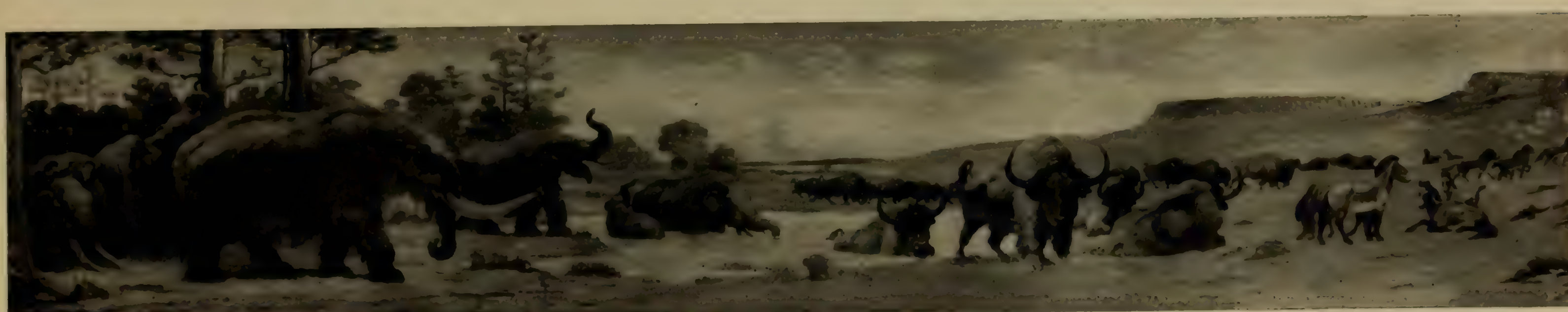
The scene represents the two herds, reindeer and mammoth, migrating along the banks of the river Somme not far from one of the great encampments of men of the Crô-Magnon race. These reindeer and mammoths are, in fact, depicted very precisely in the paintings and engravings left by the Crô-Magnon artists—especially in the cavern of Font-de-Gaume. It is a striking fact that, in the case of the mammoth, every painting, drawing, etching, and model which the Crô-Magnon man has given us exhibits exactly the same characters: the long hairy covering, the very high hump above the forehead, the notch between the hump and the neck, the very high shoulders, the short back, the rapid slope of the back over the hind quarters, the short tail. There is no doubt that aided by these wonderful Palæolithic designs, the artist, Mr. Knight, has given us a very close representation of the actual appearance of the woolly mammoth.

Summer on the Missouri

The summer scene on the Missouri River (on the parallel of Kansas) represents the region south of the farthest advance of the ice sheet. The mastodons are grouped in such a manner as to show the characteristic low, flattened head, the long low back, the symmetrical fore and hind quarters, the extremely short, massive limbs, and the very broad and massive hip region as seen from behind. In the center of the picture stands the majestic *Bison regius,* the royal bison, known only from a skull, a superb specimen, with the horn cores attached, in the collection of the American Museum. These animals were like gigantic buffalo or bison, beside which the modern buffalo would appear very diminutive. The characters of the hair and wool are not known, but it is assumed that they were similar to those of the existing buffalo, since the paintings of the bison by the Crô-Magnon artists in France all show the distinctive beard below the chin. At the right is a group of wild American horses of the period, the last of their race in this country; the

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph

Late Winter—"The Reindeer and Mammoth on the River Somme, France" (mural on the north wall at the left).—It is thought not improbable that herds of mammoths, rhinoceroses; and reindeer migrated northward and southward with the seasonal changes. As the mammoth was faithfully depicted by the Crô-Magnon artists—especially in the cavern at Font-de-Gaume), and as mammoth skeletons have been well preserved, there can be little doubt that the present representation by Knight is a close likeness, of this huge proboscidean. The woolly mammoth resembled greatly an Indian elephant but was somewhat larger, was covered with coarser hair, and had larger and differently curved tusks. Whole carcasses of these beasts have been found frozen in the ice fields of Siberia where they probably survived later than in Europe



Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph

Midsummer—"The Mastodon, Royal Bison, and Horse on the Missouri River, in the Latitude of Kansas" (mural on the north wall, at the right).—This mural presents a summer scene in a region of North America south of the farthest advance of the ice sheet. The great mastodon (left) with flat, elongated head and extremely short massive legs survived in America to a time contemporary with man in Europe, but no mastodons lived in Europe at such a late period. In the center of the picture are seen the royal bison (*Bison regius*), the gigantic forerunners of our present bison. At the right is a group of the last species of native American horse (*Equus scotti*) which disappeared before the appearance of man on the North American continent

Detail of American Museum mural by Charles R. Knight. Copyrighted photograph

THE MASTODON

Believed to have been contemporary with early man in North America, though so far, there is no positive evidence that such was the case.

Detail of American Museum mural by Charles R. Knight. Copyrighted photograph

THE MAMMOTH

A contemporary of early man in Europe, carved by him in bone and ivory and painted many times on the walls of caves.

species is *Equus scotti,* the skeleton of which has been discovered in northern Texas.

Autumn in New Jersey

The autumn scene in northern New Jersey embraces three very distinctive North American types of the period, all of which have become extinct. The deer-moose (*Cervalces*) (to the left) was described by Professor W. B. Scott, of Princeton, from a single skeleton found in the gravel beds of northern New Jersey, which is now preserved complete in the Princeton Museum. The American fossil tapir (in the center) is known from sparse remains, the best of which were among the earliest discoveries of the pioneers of American palæontology. The giant, beaver-like animals of the genus *Castoroides* (see two individuals at the right in the painting) are known from nearly complete skulls and skeletons discovered in Ohio and other central western states. They are not true giant beaver.

The remaining mural of this series will represent a scene in southern California, in the vicinity of the Rancho-la-Brea deposits, including the remains of the astonishing group of animals caught in the asphalt trap, so splendidly represented in the collection of the Museum of History, Science, and Art, of Los Angeles.

Closely Related North and South American Mammals of the Glacial Epoch

The most characteristic animals of North and South America that lived during the Age of Man (see the south side of the hall) are known through some of the unique remains from the famous deposits of Rancho-la-Brea of southern California, especially the sloths, saber-toothed tigers, and wolves of the period—to which it is hoped that we may add some of the less abundant forms, like the camel and the horse. So far as possible, through exploration and exchange, this quarter section of the hall will represent the mammalian life of North America, in contrast with the mammalian life of South America during the same period of time.

The Museum is also extraordinarily rich in the great Pampean Collection presented by certain of the trustees in 1899. This collection shows the close connections between North and South America in glacial times.

One of the most wonderful fossil groups in the Museum, if not the most wonderful, is the sloth and glyptodont group (center of southern side of the hall of the Age of Man). This group is still in preparation. It includes five sloths of two varieties (the *Mylodon* and *Scelidotherium*) and three glyptodonts. These animals, so entirely different in external appearance and habits, nevertheless belong to the same order of mammals, the Edentata, which, as its name implies, is distinguished by the absence of enamel on the teeth. It is important to bring these two animals together in the same exhibit, so as to show the very wide contrasts in adaptation which may occur within the limits of a single mammalian order: the sloths covered with long hair and with vestiges of armature embedded in the skin, the glyptodonts nearly hairless, and encased in powerful bony armature, which renders them completely immune to attack by the saber-toothed tiger of the period.

A Loess Storm on the Pampas of Argentina

A mural on the western wall (at the left) of the hall of the Age of Man presents a South American scene during the Old Stone age. It depicts the ancient pampas of Argentina with the winding river La Plata in the background, and a typical extinct mammalian fauna. In the distance at the right a violent dust storm is transporting columns of finc, impalpable dust known as loess.

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph

AUTUMN IN NORTHERN NEW JERSEY DURING LATE GLACIAL TIMES

This mural (on the east wall, at the left) presents three extinct North American animals: the deer-moose or *Cervalces* (at the left), the tapir (center), and a great rodent, *Castoroides* (on the right). The rodent, much larger than a beaver, dwelt in the northern swamps. Its nearest relative is a large coypu rat of South America. The *Cervalces* had antlers neither as branching as those of the elk nor as flattened as those of the moose. An almost complete skeleton has been recovered from the gravel beds of New Jersey. Tapirs were at one time widely distributed, particularly over the Northern Hemisphere, but are now found only in restricted and widely separated more southerly regions.

The mammalian life of North America, as contrasted with that of South America during the same period of time, will be illustrated in a section of the hall of the Age of Man. The most characteristic animals of this Age—sloths, saber-toothed tigers, wolves, camels, and horses—have been taken from the deposits of Rancho la Brea in southern California, where they were caught and preserved in the asphalt quagmires

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph

A LOESS STORM ON THE PAMPAS OF ARGENTINA

A mural of South American mammalian life of the Old Stone age, in the hall of the Age of Man (*on the west wall at the left*)

In the distance a violent storm is transporting columns of loess or fine dust (of which extensive fossil-bearing deposits are found in various parts of the world). The scene is laid along the banks of the La Plata River where many great fossils have been discovered buried in the loess. In the foreground are two very different extinct species of edentates, a group which includes the armadillo, anteater, and sloth. Those with armor at the right are glyptodonts; the long-haired ones at the left are mylodonts. In the background at the right are shown a number of macrauchenias, a three-toed, hoofed animal, while at the left are seen the rodent-like toxodonts, ungulates or hoofed animals also but as large as rhinoceroses. The American Museum has an unusually fine fossil collection from the Pampas, showing the close connections between North and South America in glacial times. Discoveries by Nordenskiold in a cave at Last Hope Inlet, Patagonia, indicate that one species of these great ground sloths, known as Grypotherium, was kept in captivity, or in a state of domestication, by the primitive inhabitants of that region